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THERE seems to be much activity in railroad building in the far East. In India a great deal of work is going on, chiefly in the building of lines to develop the wheat-growing districts—a matter which has considerable interest for us in this country—and in Burmah the English are pushing the construction of lines in their newly-acquired territory. In Siam some surveys are in progress for a system of lines, although it is uncertain yet how much work will be done, if any, while in Sumatra two lines of considerable local importance are under construction by the Dutch. No work from these quarters, however, is likely to come to this country, the material being all supplied from Europe.

IN Japan, as was noted in our columns some time ago, a good deal of work is going on on new railroad lines both for the Government and for private companies. Early in April the trunk line connecting Tokio, Kioto, and Osaka was finally completed and opened for business. The Sendai Line, which is to stretch the whole length of the main island from Tokio to its northern extremity, is opened for about half of its length, and on the remainder considerable progress has been made. Work is also in progress on several branch lines, and at the present rate it will not take very long for the railroad system of Japan to assume importance both on account of its mileage and the amount of its business.

THE Russian Trans-Caspian Line, although built, as we have heretofore said, entirely for military purposes, is already carrying a commercial traffic which more than pays its working expenses, and a beginning will soon be made on the extension of the main line to Tashkend. The latter city is an important center, both commercially and politically, and is also situated at the head of navigation of the Syr-Daria River. Besides this extension a considerable amount of work is to be done on the Trans-Caspian road, so as to increase its carrying capacity and to give it a more permanent character than was at first done.

In this connection we may note that the management of the railroad has undertaken to provide for the little Russian colonies along the line of the road, which are mainly composed of employés of the road and their families, by fitting up a car as a school-house and another one as a church. These cars contain sleeping accommodations and other provisions for the comfort of their occupants, and are moved from station to station, so that the schoolmaster and the priest are enabled to attend to the mental and spiritual wants of a very widely scattered population with comfort to themselves, and with very little loss of time.

THE engineers who have been making the preliminary surveys for the Siberian Pacific Railroad have been for some time past occupied in preparing their reports, and the result of their work, it is stated, is considered very satisfactory by the Russian Government. The surveys have shown that the greater part of the work will be comparatively light, and that heavy grading will be needed only at a very few points. The largest and most expensive engineering work will be the bridge over the river Irtish, which will be 1,900 ft. long. There are several other important river crossings, but none of them more than 800 to 1,000 ft. in length. The estimate for the cost of the entire line, with pile or other wooden bridges, and with a moderate amount of rolling stock, is 25,000 rubles per verst, or $19,000 per mile.

The route selected runs from Zlatoust by way of Kourgan, Omsk, Tomsk, Irkutsk, thence across the Southern Baikals, through Posolskaya, Tchita, Sraitensk, and the Amoor Valley to Vladivostock.

Practically work has already been begun, as a commencement has been made on the extreme eastern end of the line, which is to connect Vladivostock with the Amoor settlements, while on the western end progress is being made on the line from Ufa to Zlatoust, which is really the first section of the road.

The undertaking is a very popular one in Russia, and is also said to be a favorite project of the Czar, so that there is every probability that work upon it will be undertaken in earnest within a short time, especially as Russia is just now in a very good financial condition.

THE relative advantage of the broad and narrow gauge is a question which has passed beyond the point of argument in this country, having been practically settled by the gradual disappearance of the narrow gauge, but it is still under discussion in India, and some curious remarks on this subject are made in a paper recently read by Mr. Waring before the Institution of Civil Engineers. The result there has been generally the reverse of what was expected by the advocates of the narrow gauge, for the cost of working those lines has been generally much higher, in proportion to the receipts, than that of the broad-gauge lines. This has partly been due to the fact that they are generally roads of much lighter traffic, but the fact remains, as stated by Mr. Waring, that taking the average of all the lines of meter gauge—which was the gauge adopted for the narrow lines in India—the cost per ton-mile for all working expenses and per locomotive-mile for motive power were considerably higher than on the roads of 5 ft. 6 in.—the Indian standard—and the only single item upon which the narrow gauge showed an advantage in working was in repairs of cars. As to the difference in

first cost, Mr. Waring thinks that the only gain was due to the fact that most of the narrow-gauge lines were built for a light traffic and in a much less substantial manner than the others; this seems to be confirmed by the statement that the expenses of maintenance of way have been much higher in proportion on those lines.

THE Verrugas Viaduct, which was built in 1872, and which at that time attracted much attention from the daring nature of its design, and from the fact that it was then the highest bridge in the world, or one of the highest, was destroyed in March last by a landslide, which swept down the ravine spanned by the bridge, carrying away the central pier and the two spans which rested upon it. This bridge carried the Lima & Oroya Railroad over a deep ravine, through the bottom of which flowed the little River Rimac, and was built by the Baltimore Bridge Company. It consisted of four spans supported by two abutments and three iron towers, which were respectively 179 ft., 252 ft., and 146 ft. high from their masonry foundations.

The Lima & Oroya Railroad, which was intended to cross the Andes and establish connection between the coast and the famous Cerro de Pasco silver mines, and also to connect Peru and Bolivia, was one of the works undertaken by Henry Meigs for the Peruvian Government, and was one of the most notable railroads in the world, involving much extremely difficult and expensive work, including tunnels, bridges and embankments. A large amount of money was spent upon it, but owing to the condition of the Peruvian Government it has remained unfinished, and has been of comparatively little importance commercially.

ONE of the events which will take place in Paris this summer is an International Geographical Congress, which will sit in that city, August 5-11, and to which delegates from organized societies all over the world are invited. The Congress will be divided into six sections, and committees are preparing, as far as possible, the business for each. The divisions are as follows:

1. Mathematical: Geodesy, Hydrography, Topography, and Cartography.
2. Physical: Meteorology and Climatology, Geology, Botanical and Zoological Geography, Oceanic Geography, Ethnology, Medical Geography.
3. Economical: Commercial and Statistical Geography.
4. Historical: History of Geography and Cartography.
5. Didactic: Diffusion of Geographical Knowledge.
6. Travels and Explorations.

Geographical societies all over the world are asked not only to send delegates, if possible, but also to contribute accounts of geographical progress in their respective countries, including notes of travel and exploration, etc. These notes are to be compared and edited by a committee which will be appointed at the Congress, and are finally to be published in book form as the record of geographical progress in the nineteenth century. The attendance at the Congress will, it is expected, be large, and many distinguished men will be present.

THE statistics of geographical societies throughout the world have been collected by Herr H. Wichmann, the result of whose investigation is given by the *Bulletin* of the American Geographical Society. According to this authority the societies devoted to geographical science number in all 101, with 44 branches, and these are located in 21 countries and 135 cities. The French are usually credited with not caring much for what goes on outside of their own country, but nevertheless France takes the lead with 29 societies, having 19,800 members. Germany, which might be expected to be first, follows at a long interval, having 22 societies, with 9,200 members. Great Britain has nine societies, with 5,600 members; Austria-Hungary two, with 1,950 members; the United States three, with 1,500 members; Russia five, with 1,330 members; Switzerland six, with 1,000 members; no other country having more than one society. Russia and the United States, as the two nations having the most extensive territory and the greatest opportunities for development, might be expected to make a better showing, although it may be said that they are both too much occupied in making geography to have much time for studying it.

The geographical journals of the world—including only those exclusively devoted to that subject—number 130. Of these 45 are published in the French language; 41 in German; 10 in English; nine in Russian; six in Italian; six in Portuguese; five in Spanish; three in Dutch, and one each in Danish, Swedish, Hungarian, Roumanian, and Japanese. These journals are classed by languages and not by countries; for instance, the French include two or three published in Belgium, the German those published in Austria as well as in Germany, and the English those published in the United States. No attempt has been made to otherwise classify these journals, which differ very widely in size and in the value of their contents, some having merely a transient interest, while others are of more permanent value, from the nature of their contents and the ability with which they are conducted.

THE protection of workmen from accidents and the prevention of accidents in factories are now engaging much attention in France. The present movement is a little remarkable from the fact that its chief promoters do not rely upon Government aid or Government regulation, as it is the usual French custom to do, but advocate independent action. An Association for the protection of workmen from accidents has been established in Paris and has formed branches in many of the manufacturing cities throughout France, and this Association has already made considerable progress in its work. It is an enlargement or copy of a similar society which has existed for some years at Mulhouse, in Alsace.

This Society acts through a corps of inspectors, composed of engineers and of experienced workmen, who visit factories with the consent of the proprietors, generally freely given, giving advice in relation to the proper safeguards to be employed with machinery and to the use of various safety devices, and in general acting as consulting engineers. Pamphlets on measures for prevention of accidents are also issued and circulated largely among mill-owners and workmen, and, in general, efforts are made to educate public opinion in this respect.

From some interesting statistics given by the Society it appears that for a series of years, what might be called factory accidents or accidents to workmen resulting directly from their work have been in the proportion of about 47 to each 1,000 persons employed; these figures being collected from establishments employing very nearly 2,000,000

workmen. From a careful analysis of these accidents and their causes, it is estimated that 20 per cent. of them are due to the carelessness of the workmen themselves; 30 per cent. to the absence of proper safeguards, while perhaps 50 per cent. might be considered unavoidable. It is believed, however, that the 50 per cent. could be considerably reduced by the use of proper precautions.

Two extensions of the present elevated railroad system in New York might be suggested, which would certainly add very much to its efficiency. Both of them have probably been considered by the Company, and both have probably occurred to almost every one who has studied the subject at all. The first is an extension of the Third Avenue Line from its present terminus transversely, on a line nearly parallel to and not very far from the Harlem River, to a junction with the Sixth Avenue Line near its present terminus. This would make of the Third and Sixth Avenue lines a continuous belt line, would obviate the necessity of turning trains, enable trains to be run almost continuously, and would furnish needed accommodations for a section of the City which is filling up very rapidly. The other is a continuation of the present Forty-second Street Branch from the Grand Central Depot to a junction with the Sixth, and, if possible, with the Ninth Avenue Line. This would make an additional loop or cross-connection, and would be of great service to the large travel to and from the Grand Central Station.

THE resignation by Mr. Albert Fink, of the office of Trunk Line Commissioner, leaves vacant a very important position, of which Mr. Fink has been the only incumbent. It will be difficult to find a successor who unites in his own person so many qualifications for the work. As General Superintendent of the Louisville & Nashville Railroad, Mr. Fink distinguished himself, not only as a railroad manager, but as a man who had carefully studied and thoroughly mastered the intricate problems attending the course of railroad traffic in this country. As Commissioner of the Southern Railroad & Steamship Association, he showed himself capable, not only of understanding a difficult situation and of holding together the Association against very strong disturbing influences, but also of commanding the entire confidence of the members at a time when their interests were often widely opposed. When the Trunk Line Association was formed his reputation was so high that he was really the only candidate named for the office of Commissioner, and it is largely due to his exertions and to the confidence felt in him that even the limited success which it has obtained was secured.

THE American engineers who joined in the European trip have met with a most cordial reception in England from the different Engineering Societies and from various public and municipal bodies, and have been treated in a most hospitable manner in every direction. Their visit to England has been enjoyed to the utmost, and, judging from the comments of the English engineering press, the visitors have made a very favorable impression upon their hosts. A number of the party are now in Germany, where their reception promises to be a very hearty and agreeable one.

THE survey of the waters, or Hydrography, is a branch of engineering of which very little is usually known outside of those who are directly concerned, but which is, nevertheless, of no small importance. The article on another page, in which some account is given of the methods employed and the results obtained, will be found of interest.

In this connection it may be noted that while the science itself is of very early origin, its present advanced condition is largely due to the American hydrographers who have done honor to our naval service.

THE stockholders of the Chesapeake & Ohio Canal have held a meeting in Baltimore, and authorized the President and directors to make use of all available resources for the purpose of putting the canal in repair. In spite of this action, however, it is considered very doubtful whether the canal will ever be used again as a water-way. The lowest estimate is that it will cost $250,000 to put the canal in passable condition, and $350,000 to restore it to the condition in which it was before the recent flood; and it will not be possible to have it opened for navigation until next year, even were the money immediately available. The company's credit, however, is not very good, as the canal is already overburdened with debt, and it is quite possible that the money required will not be raised unless the State of Maryland, which is the chief stockholder, comes to the rescue. The canal-bed is valuable for a railroad, but the present chances are that it will be abandoned as a navigable channel.

A COMMITTEE of the United States Senate is now engaged in investigating the practicability of building reservoirs in the Rocky Mountains and the Sierra Nevada, to store up and utilize water for irrigating purposes. A number of preliminary surveys have been made in this direction, to ascertain as nearly as possible the amount of water which can be stored, and the extent of land capable of irrigation, and public attention on the Pacific has been very strongly drawn in that direction. There is no doubt that a great deal can be done in the way of utilizing lands now considered barren by irrigation, and the object of the Senate Committee is to ascertain whether the assistance of the National Government will be required to make this available.

THE Navy Department has been reorganized under the new Secretary; the purpose of the change made being to simplify the work of the different Bureaus of the Department, and to arrange their work so as to avoid, as much as possible, interference with each other. There are eight of these Bureaus, having respectively charge of Navigation; of Yards and Docks; of Equipment and Recruiting; of Ordnance; of Construction and Repairs; of Steam Engineering; of Medicine and Surgery; and of Provisions and Clothing. In addition to these the work of the Department includes the offices of the Judge Advocate General and of the Marine Corps. The organization proceeds very much on the lines which were laid down by Secretary Whitney, but which the close of his term did not leave him sufficient time to complete.

THE RAILROAD TIME SYSTEM.

THE success of the railroad time system, which is now in general use in the United States, has naturally attracted some attention abroad, and its manifest excellence and convenience has been appreciated by railroad managers

and others, who have had some opportunity of seeing its working. In England there has been some discussion upon the question, but the differences of time in that country are comparatively so small that it is not a question of moment. On the continent of Europe, however, and especially in France and Germany, it has been taken up, and the adoption of something similar to the American system finds many advocates.

The latest of these is Dr. Plechawski, of Vienna, who has been studying the question and has written an elaborate article upon it. He is not satisfied with a limited application, but, with German thoroughness, he proposes to extend it to the whole world, and to establish an international time system, by which the entire circuit of the globe shall be divided by time-meridians, at intervals of 15°, or one hour apart, so that uniform time will be kept in all places within a given time-zone. He has worked out the details of the proposed system as far as to suggest names for the 24 hours, or time-zones, into which the earth will be divided under his plan.

The advantages of our present arrangement over the confusion which formerly existed have been made so apparent by a few years of use that opposition to it has practically ceased in this country, and it is not unlikely that before long its general adoption will be secured, at least in all civilized countries. German opinion seems to be strongly in favor of it, and German influence in Europe will be of great assistance to the movement, although English opposition may for some time, by its obstinate conservatism, delay the completion of any general international agreement on the subject.

NEW RAILROAD BUILDING.

THE construction of new railroads during the first half of 1889, according to the records kept by the *Railway Age*, amounted to 1,522 miles ; this mileage being divided among 123 different lines. The total amount is somewhat less than half of that reported for the same period in 1888, although the mild winter made the early part of the year unusually favorable to tracklaying in the Northern and Northwestern States. The total mileage for 1888 was about 7,100 miles, and taking the same ratio for this year, the report for the first half would indicate a total increase of railroad mileage in 1889, of about 3,500 miles. From present indications it is not at all likely to exceed that, since there are fewer new lines in progress than there were a year ago, and much less grading and preliminary work has been done.

The average length of the lines built this year, it will be seen, is between 12 and 13 miles, and this well indicates the fact, which has been stated before, that the new construction of this year is chiefly of short lines, branches, and feeders. No long lines or extensions—like the Montana Line of the St. Paul, Minneapolis & Manitoba, or the Kansas lines of the Rock Island—are now in progress, nor does it seem likely that any will be undertaken at present. The experience with competing lines in the Northwest and the Southwest has not been of a nature to encourage more building of the same kind, and, in fact, most of the companies which have been engaged in that business are not just now in a condition to keep it up. The Northwest practically stopped the building of competing lines two or three years ago, and that section of the country reports a smaller new mileage than for a number of years past.

The figures given by States are interesting. For the first time the Southern States take the lead, the five reporting the greatest mileage being Mississippi, 171 ; Georgia, 142 ; North Carolina, 106 ; Tennessee, 105, and Texas, 101. No other State had over 100 miles. A larger proportion has been built in the Middle States than for some years past, 87 miles having been constructed in Pennsylvania, 71 in New York, and 41 in New Jersey. In New England new railroad building seems practically to have ceased for the present ; in the West and Northwest it was very light, Michigan, Indiana, Illinois, Minnesota, and Wisconsin together having only 47 miles in all to their credit ; while the Southwest makes an almost equally poor showing, Missouri, Kansas, and the Indian Territory together reporting only 104 miles. On the Pacific slope also there has been a great decrease, 50 miles in California, 12 in Oregon, and 62 in Washington being the totals.

The Southern States lead this year, mainly owing to the increased activity in the development of their mineral resources and the building of short lines to open up new mining districts and to accommodate new manufacturing towns. The only long line in that section now under construction is the extension of the Georgia Pacific to the Mississippi River.

The condition of affairs shown by this statement cannot, however, be considered altogether discouraging ; it is true that there has been increased difficulty in securing money for new enterprises, but the new railroads which are now being built are precisely those which are really needed by the country, and which will best aid in its development. Competing lines are at the best a doubtful investment for capital, and may be considered as, in large part, a waste of the resources of the country, which might be better applied. The growth this year is a more healthy one than that of the two or three years lately past, and the industrial interests of the country will not, in the long run, suffer seriously by the present partial suspension of activity in the direction of railroad building.

NEW PUBLICATIONS.

THE OFFICIAL RAILWAY LIST AND HANDBOOK OF USEFUL INFORMATION FOR RAILWAY MEN : EIGHTH YEAR. Chicago ; published by the Railway Purchasing Agent Company.

The *Official List* is sufficiently well known to railroad men and others who have occasion to use such a publication to require no very extended notice. The present number is in the usual form, with no further changes than are needed to bring the information it contains up to date. It is a publication which is necessary to all of the very numerous class of business men and others who have occasion to communicate with railroad men of various classes and to know their addresses.

One suggestion might be made : it is their custom to publish monthly, in the *Master Mechanic*, a record of changes in railroad officers. If it is practicable to send those changes to subscribers to the *Official List* monthly in such a form—on small slips printed on one side only, for instance—that they could be cut out and pasted in their proper places in the book, it would be a great convenience to many who have occasion to use it. We give this as a hint to the publishers, who have always shown themselves

ready to do anything needed to make the list as complete as possible.

Transmission of Power by Fluid Pressure. Air and Water: by William Donaldson, M.A. New York and London; E. & F. N. Spon.

This book is a statement of the rules governing the use of hydraulic pressure and of compressed air for the transmission of power, and is accompanied by a comparison of the relative advantages of the two for this purpose, to which are added a chapter and an appendix on the special case of the application of compressed air and high-pressure water for pumping sewage. It is a convenient manual for those who wish to study the subject, as the formulas given are all worked out mathematically, so that the whole process can be studied by those who desire it, and who do not want merely to accept the results, as given in the author's tables.

His opinion of the relative advantages of air and water for the transmission of power does not require much search to discover, for it is plainly expressed in the following, which is the very first paragraph in the introduction:

> It is clear that an incompressible fluid like water, subject to no changes except freezing, which can easily be guarded against, must be a much better medium for transmitting power than an elastic fluid like air, which cannot be compressed without great increments of temperature corresponding to the increments of pressure. The absolute energy imparted to the air during compression is equal to the equivalent in work of the number of thermal units required to raise the temperature of the air to that due to adiabatic compression, and must therefore be wholly lost, if the air without doing work is cooled down to the original temperature of the free air. The work done by expansion down to atmospheric pressure after cooling corresponds to an equal loss of the absolute energy possessed by the air before compression. This cooling-down to the temperature of the medium surrounding the pipes is inevitable, when the air is transmitted to considerable distances, unless the pipes are coated with some non-conducting substance. Heat must also be lost in the very act of compressing the air.

Water is very much less used for the transmission of power in this country than in England, where it is applied for many purposes and used in many places where in this country we use steam or hand-power, and lately to some extent electric motors. It has always seemed to us that the use of hydraulic machinery could be very much extended to advantage, and any book which brings the subject to the attention of engineers will be of service.

Steam Boilers. Their Management and Working on Land and Sea: by James Peattie. New York and London; E. & F. N. Spon.

The object of this book can probably be best expressed in the Author's own words in the preface:

> As nearly all the writers on this subject have been non-practical, therefore, notwithstanding their scientific attainments, reasonings, and data being ever so scientifically correct as a whole, their writings are void of many important details and important practical facts; and being couched in abstruse and technical language, are unintelligible to the mass of persons in charge of steam boilers, and uninteresting to others, who fail to find in them the particular counsel they desire.
>
> Under such circumstances it is obvious that much conflict of opinion and conflict of practice will exist among those in charge of steam boilers, and even among practical men, regarding the subject. Any effort, therefore, to treat the subject in a thoroughly simple yet practical manner, in the language of the engine-room, the workshop, and the factory, will be welcomed by those having a *bona fide* interest in the management and running of steam boilers.

The Author claims 30 years' practical experience, and this book is the outcome of his notes taken during that time. It relates almost entirely to English practice, but necessarily contains a great deal that will be of service to boiler-makers and boiler-users everywhere. Not all his conclusions will be accepted, but many of them are sound, and the book contains many useful hints. An excellent feature, which is lacking in too many books of this kind, is a very complete index.

The book is written in a somewhat offhand and familiar style, and a great many of the principles laid down are accompanied by illustrations drawn from practice.

Reference Book of Interlocking and Signaling Devices and Parts Used in Connection Therewith, as Manufactured by the Union Switch and Signal Company. Swissvale, Pa.; issued by the Company.

The title of this book does not give a distinct idea of its character. In the preface it is said that the Company has aimed to furnish a book "from which their patrons can order any part or parts entering into interlocking and signaling for repairs, alterations or additions" thereto; and also "to give as much general information as they deemed consistent with the nature of the book, and thus enable those not thoroughly versed in interlocking to intelligently select from the various devices shown one adapted to their purpose." In reviewing a really good book, adverse criticism always seems to be an ungracious act, and the duty of pointing out the defects in a work which is more worthy of commendation than condemnation is attended with more or less perplexity. If a review of such a book begins with adverse criticism, it is hard to remove the impression produced thereby by any amount of commendation thereafter. If, on the other hand, the best features are pointed out first, and attention is called to the defects last, the final, which is often the lasting impression, is an unfavorable one. In the present instance the duty devolving on the reviewer is to say, first, that this book accomplishes one of its purposes—that of a catalogue of the parts of interlocking and signaling apparatus manufactured by the Union Switch and Signal Company—exceedingly well; but the critical reader wonders why the Author, in his "endeavor to give as much general information as he deemed consistent with the nature of the book," made it as good as it is, and then did not make it much better. A comparatively small additional amount of work would have made this the best treatise on that subject in the English or, perhaps, any other language.

But to return to commendation: the book measures $5\frac{1}{4} \times 8\frac{1}{2}$ in., is bound on one of the short sides, or opens endwise, and has 364 pages printed on thin paper, so that it can be carried in an overcoat pocket. It has 136 full-page engravings and about 30 smaller illustrations, showing plans and details of signaling apparatus. The general plan of the book is to give short descriptions of the various kinds of apparatus manufactured by the Union Switch and Signal Company, and which are followed by engravings and lists of the various parts, which are designated and numbered, so that they can be conveniently ordered by those who need duplicate parts. For this purpose the illustrations are admirable, and the lists, with explanatory paragraphs, are all, apparently, that could be desired; but the descriptions of the various systems of signaling are inadequate, and not clear enough to be easily understood. For example, unless he has some considerable knowledge

of the Saxby & Farmer Interlocking Machine, it seems doubtful whether any one could understand its construction from the description on pages 8 to :6. The same thing is true of other parts. More lucid description would have added greatly to the value of the book. As it is, much of it is infuriating to a person anxious to learn how signaling apparatus of various kinds is constructed. While the reader often yearns for fuller explanation of the systems of signaling which are described, on page 66 the fact that metal expands when heated is explained at considerable length.

The book, however, has one very great merit—it is all fresh; the engravings are from original drawings, and the mechanism illustrated is of recent construction, and much of it from original designs. It has been remarked before that it looks as though in the future the most valuable technical treatises will be the trade catalogues issued by manufacturers. While the book before us hardly fulfills this prognostication, yet, while it can hardly be regarded as a valuable treatise, it comes near to being so, but is, nevertheless, a very useful "reference book" on signaling apparatus, and in the present dearth of literature on that subject will do good service in place of what is now much needed—that is, a really good treatise on railroad signals.

BOOKS RECEIVED.

The New Omaha Bridge: a Report to Charles Francis Adams, President of the Union Pacific Railway Company: by George S. Morison, Chief Engineer of the Omaha Bridge. New York; issued by the Company.

On the Use of Petroleum as Fuel in Locomotive Engines: by Thomas Urquhart. London, England; published by the Institution of Mechanical Engineers. This is a reprint of the paper read by Mr. Urquhart to the Institution of Mechanical Engineers, and contains also the discussion on the paper.

Selected Papers of the Rensselaer Society of Engineers, June, 1889: edited by the Committee on Publication. Troy, N. Y.; published by the Society. The present number contains papers on Stand-Pipes, by Wynkoop Kiersted, and Notes on the Theory of Cantilever Bridges, by Charles McMillan.

Canada, Statistical Abstract and Report for the Year 1888: Prepared by the Department of Agriculture, S. C. D. Roper, Compiler. Ottawa, Canada; Dominion Printing Office.

Annual Report of the Commissioner of Patents, for the Year 1888: Benton J. Hall, Commissioner. Washington; Government Printing Office.

Report of the Chief of the Bureau of Statistics, Treasury Department, on the Imports, Exports, Immigration and Navigation of the United States, for the Quarter Ending March 31, 1889: William F. Switzler, Chief of Bureau. Washington; Government Printing Office.

Interstate Commerce Commission: Revised and Amended Rules of Practice in Cases and Proceedings before the Commission; Adopted June 8, 1889. Washington; Government Printing Office.

List of Boards of Trade and other Commercial and Industrial Organizations of the United States: being Statement No. 47 of Quarterly Report No. 3, Series 1888–89, of the Bureau of Statistics, Treasury Department. Washington; Government Printing Office.

National Association of Builders of the United States: Proceedings of Third Annual Convention, held in Philadelphia, February 12–14, 1889. Boston; issued by the Association, William H. Sayward, Secretary.

The School of Mines of the University of Missouri Catalogue, 1888–89. Rolla, Mo.; issued by the University.

Automatic and Variable Cut-off Blowing Engines for Blast Furnaces, Bessemer Works, Air Compressors, etc. Philadelphia; Gordon, Strobel & Lareau, Limited, Engineers. This is an admirably illustrated catalogue of a class of engines called upon to do very difficult and exacting work, and requiring special knowledge and experience in their design and construction. It is of interest for that reason.

ABOUT BOOKS AND PERIODICALS.

The last number of the Bulletin of the American Geographical Society contains a continuation of the interesting article on the Portuguese in the Track of Columbus; an article on the Hawaiian Islands, by Dr. Coan, and a long and interesting article on the Great Basin, the most distinguishing geological feature of the North American Continent, by Professor William H. Brewer. There is also the usual variety of geographical notes, home and foreign.

Among the articles in the latest number of the Proceedings of the United States Naval Institute are—An Outline of a Scheme for the Naval Defense of the Coast, by Captain W. T. Samson, and Domestic Steels for Naval Purposes, by Lieutenant-Commander J. G. Eaton. Other articles are on Collisions at Sea; the Right of Way at Sea; the Efficacy of Oil for Subduing the Violence of Waves; the Cruise of the *Vandalia*, and a continuation of Notes on the Literature of Explosives.

Among the new books announced by John Wiley & Sons are a Treatise on Ordinary and Partial Differential Equations, by Professor William Woolsey Johnson; Submarine Mines and Torpedoes, by Lieutenant-Colonel J. T. Bucknill, Royal Engineers; and Elements of the Art of War, prepared for the use of the cadets of the United States Military Academy, by Professor James Mercer.

Manual Training, which is receiving so much attention at present, is the subject of the first article in the August number of the Popular Science Monthly. This article is by Professor C. H. Henderson, of Philadelphia. Another suggestive article in the same number is on the Wastes of Modern Civilization, by Dr. Felix L. Oswald.

The Journal of the Military Service Institution for July has two interesting articles on the higher military education—An American War College, by Lieutenant Arthur L. Wagner, and New Course of Instruction at Fort Monroe, by Captain W. E. Birkhimer. Other articles are on Mobilization; on Infantry in the Field, by Lieutenant Wisser, and on Cavalry Gaits, by Captain Dorst. Translations include Mounted Infantry; French Field Artillery, and the continuation of Prince Hohenlohe's papers on Infantry and Artillery.

The leading article in the July Century is by Charles Barnard on the Inland Navigation of the United States. It contains some facts and comparisons of interest; it is illustrated by views of a Western river boat, a Lake boat, the Hudson River steamboat *New York* and the new sound steamer *Puritan*. An omission which might be noted is the absence of any illustration of one of the great freight carriers which are fast replacing on the Lakes the type of steamboat pictured in the article.

The electrical article in Scribner's Magazine for July is on the Telegraph of To-day, and is a history of the growth and improvement of the telegraph. It includes an account of the

duplex and quadruplex methods of telegraphing, and of the Phelps-Edison train telegraph system.

The Discovery of the Mississippi is discussed in the July number of the MAGAZINE OF AMERICAN HISTORY, by Henry Lee Reynolds, who makes out a strong case for Alonzo de Pineda as against the rival claims of De Soto and Cabeça de Vaca. Pineda was sent from Jamaica in 1519 to explore the Gulf of Mexico, and there seems to be little doubt that he entered the Mississippi and sailed up it a short distance.

In the OVERLAND MONTHLY for July, Henry S. Brooks writes of the troubles of American capital and business in Mexico, but doubts whether the annexation of that country to the United States is at all probable.

The latest addition to the list of railroad papers is THE CAR, a new monthly published in Philadelphia. A large part of its contents relate to street railroads, but steam railroads are not neglected, and there is a variety of news, gossip, and other interesting matter.

The WALL STREET JOURNAL is a new financial paper of the kind which has grown to be very useful and almost indispensable to a large class of persons. It is published in New York by Dow, Jones & Company, who, as proprietors of a financial news agency, have a reputation as enterprising and reliable gatherers of news. A special feature of this paper is the addition of a column to its table of bonds, giving the income which each bond quoted will yield to investors, at the price named in the latest quotations. This will be a great saving of time and trouble to those who consult the tables with a view to investment.

MECHANICAL TRAINING IN SCHOOLS.

To the Editor of the Railroad and Engineering Journal:

OWING to the great interest that is being shown all over the country in the question of the manual training of students, and the many advantages which have already shown themselves to be connected with this method of training carried on in connection with the ordinary school duties, I thought that the following sketch of the School of Mechanical Arts in connection with Griswold College, at Davenport, Ia., might not prove uninteresting to your readers.

Griswold College, proper, was an Episcopal Church college, and at present is only represented by St. Catherine's School for young ladies and Kemper Hall, a school for boys. Last September there was started, in connection with the ordinary course of instruction given at Kemper Hall, a course of instruction in what might be called Mechanical Arts. This department was put in charge of Mr. H. G. Sedgwick, a most accomplished mechanician. As I was to some extent instrumental in starting this work, I have followed it with considerable interest during the past year.

The idea is to have a course running through four years, which is about the time most of the boys are connected with the school. The age of the students varies from 11 to 17 or 18, the average being between 14 and 15 years. This course in Mechanical Training is not in any way intended to interfere with the regular school work of the student, but merely to give him some insight into the manner in which work is done, render him familiar with the different tools and methods of doing the work, and thus train his eye, hand, and mind to methods of accuracy which no other kind of training has yet been able to accomplish. Of course it is not intended to turn out finished mechanics, although some of the work that has been done during the past year by these young lads would put many of our professional mechanics to shame.

The machine shop of the school is very well fitted up with a 25 H.P. engine, a boiler, and various machine tools for the working of wood, iron, or steel, such as lathes, planers, shapers, drills, emery wheels, two forges, blacksmith's outfit, etc.

At the beginning of the year the boys were divided into two classes, according to their age. The smaller boys were put at some of the elementary forms of woodwork, learning the use of the plane, saw and hammer, together with elementary word-turning, scroll-work, pattern-making, etc. Students of the proper age were placed at once in charge of the different machine tools—for instance, one at a lathe, one at a planer, one at a shaper, one at emery wheels, etc. Each of these students was carefully instructed in the uses of the tools before him. The proper and improper methods of handling were both shown, he remaining at that tool for a few days until he thoroughly comprehended the reversing, stopping and starting, the proper position of the tools, the back-gear, different feeds, etc. The work done was simply the plainest kind of turning, planing, and grinding.

When they had fully mastered the use of these tools, they were shifted to others, thus bringing each student in contact with each machine in the room. This preliminary work occupied about three or four weeks. They next took up what they called "Preliminary Construction," each student having to make a plan on paper of some simple geometrical figure, such as the cube, the cylinder, the triangle, etc. They then took these plans and duplicated them in wood, thus opening an entirely new field to the young lads, and showing them the intimate connection between paper plans and wooden structures. After the plans had all been duplicated as perfectly as possible in wood, they were required to duplicate them in iron or steel, using for this purpose the proper machine tools. This work is exchanged among the different students until each of them has performed the requisite amount in a satisfactory manner. This work occupied the whole of the first term.

The second term opened with very much the same work, but each piece was now required to be made according to "gauge rule"—that is, the cubes were required to be of a certain definite size, the cylinders of a certain inside and outside diameter, the triangles of definite angles. All these were first drawn, and then duplicated in metal.

The third term was opened with simple construction. Starting with the five mechanical powers, the students constructed them in their simplest form, one student constructing a lever, another a wheel and axle, another a pulley, etc. This led up to simple combinations, such as a lever acting upon a screw, etc.

The steam-engine was now introduced, all the necessary castings being furnished, and the work of combination began. Each student was obliged to make complete plans of his engine, and during the last year each of the students constructed a 1½ H.P. horizontal engine. This closes the work as far as it has been actually carried on in the school.

The second year will be devoted to more complex forms and combinations, speed and power service machinery, the determination of values and coefficients, and will end with the construction of electric motors and dynamos.

The third year will be devoted to pneumatic and hydraulic machinery, delicate combinations, and a start in the cutting of gearing.

The fourth year gear-cutting will be completed. Train-work, escapement work, graduations, and micrometer work will be taken up.

This constitutes the plan that has been laid out for the instruction in mechanical arts, the first year of which has been completed. During this first year there have been 26 students in attendance, ranging from 10 to 18 years of age. Each of these students has constructed an engine of 1½ H.P., usually, although there has been one constructed of 4 H.P., which, upon trial, gave such excellent results as to speed, steadiness, etc., that it was purchased by the Iowa State University, for experimental use in the Testing Laboratory of the Engineering Department.

The time devoted to this instruction has been two hours a day for five days in the week. It has been found not to interfere in any way with the general standing of the students in their classes. Almost without exception those students that stood highest in their classes have taken the most interest and excelled in the department of Mechanical Arts, while other students who have never shown the slightest brilliancy in what is called "book-learning" have developed a wonderful ability in the machine shop, and have thus found occupation and have developed much latent talent, the possession of which neither they nor

their parents were aware of. All the students, without exception, have shown interest in their work, and the only trouble that has been experienced has been to keep them out of the machine shop and confine their work simply to the two hours that was required, rather than to make them attend these two hours.

Each day one of the students is put in direct charge of the 25 H.P. engine that runs the shop, and is responsible for it. Of course none of the students are allowed to touch any piece of machinery or any of the engines without having previously received full instructions from the director, or under his direction.

The physical health of the boys has been in no way interfered with, and a stronger, brighter, more interested set of boys it would be hard to find anywhere in the country than I saw the other day, when some 18 of them had their engines all connected with the boilers and each little engine was making 300 or 400 revolutions a minute.

The success of this mechanical department during the past year at the Kemper Hall School has been unmistakable, and its advantages to the boys, both in training, in habits of accuracy and in intellectual and physical development, nave been very marked. They have been exceptionally fortunate in being able to have as many fine machine tools and as elaborate a shop as they have.

There is no reason why such departments should not be started in many other boys' schools, and if those interested in the education of boys could only see and appreciate the many advantages reaped by the boys during the last year, in this one little example of the teaching of mechanical arts, I have no doubt but that much more general use would be made of this branch of instruction.

C. D. J.

THE STRENGTH OF BEAMS AND COLUMNS.

To the Editor of the Railroad and Engineering Journal:

IN justice to myself, I ask space in your JOURNAL to reply to your notice of my "Strength of Beams and Columns," contained in your July issue. For a beginning you assert, "The new theory of beams presented in this work is developed from certain hypotheses for which the Author offers no justification, either experimental or theoretical."

First, as to the "theoretical justification." The breaking of a beam or column is in the nature of a power overcoming a resistance; this makes it a machine whose mechanical movements must be clearly understood. The load is applied, motion takes place as a result, the resistance of the material is developed, and equilibrium only ensues after all motion has ceased. In such a system of forces, the center of motion is necessarily the center of resistance. Now in the book referred to, the center of motion, the action of the power or load, and that of the resisting forces are clearly defined, and as these include all of the elements of strength, no more conditions could be imposed. The correctness of the hypotheses deduced from these mechanical conditions is fully sustained by the large amount of experimental data given.

As to the "experimental justification," there is not a formula in the book that is not illustrated by from two to ten examples taken from the records of Fairbairn, Barlow, Hodgkinson, Owens, Wode, the Watertown Arsenal Tests, and other trustworthy sources. The identity between the computed and actual results varies simply with the care with which the experiments were made. The variation that exists arises principally from a lack of exact knowledge of the compressive strength, for no two experimenters would make it the same for the same material. In the carefully made tests of the Watertown Arsenal, the computed and actual results are practically identical. I do not know your exact definition for "experimental justification," but the above list of experimenters is generally considered to about exhaust all available experimental data. Moreover, I make the assertion that you cannot find a single experiment that gives correctly the crushing and tensile strength of the material composing a beam; that the strength of the beam could not have been foretold, and that if there were any difference between the actual and computed tests the difference would be practically nothing.

The following fundamental principles, "founded on universal experience," and "all the text-books," lead to many embarrassing contradictions. You say, "It is a fundamental principle of mechanics that when a *free* body is acted upon by *two* forces whose directions are opposite, *motion* will ensue unless the forces are of equal intensity. This principle applied to the horizontal fiber-strains in a beam shows that the sum of the tensile stresses must be equal to the sum of the compressive stresses." The first part of your statement is ambiguous, but your application removes this. "Two forces of equal magnitude applied to the same body in parallel and opposite directions, but not in the same line of action, constitute what is called a *couple*; its tendency is to turn the body to which it is applied," and it would require something else besides the equality of the forces to prevent motion. This is a fundamental principle, and contradicts your fundamental principle. Besides, the principle stated contradicts the basis of the theory maintained by you, for it is claimed that the moment of resistance of a beam is the moment of an equal force stress couple that has *motion* around the *neutral axis*. Moreover, the application of the common theory contradicts its fundamental principles, for it is only in such beams, whose center of gravity and center of figure coincide, that this equality of the stresses is maintained. In the T-beams, with only one flange, and in the Hodgkinson beam, the tensile stress is not equal to the compressive stress. To illustrate this, refer to the example of a Hodgkinson cast-iron beam given by Professor Wood on page 163 of his Resistance of Materials. The position of the neutral line is given by him, and you can easily figure out that the tensile stress is $13.9\,R$, and the compressive stress $9.9\,R$ —R being the Modulus of Rupture; for this example it equals 36,000 lbs., and makes the difference between the stresses 144,000 lbs. The stresses are not equal, and this contradicts the theory and your fundamental principle. Now, don't you think that this is a very poor "fundamental principle" that has to be abandoned in order to accommodate a mere change in the form of the section of the beam?

The principle that you desired to state is as follows: "In a balanced system of parallel forces the sum of the forces acting in opposite directions is equal; in other words, the algebraic sum of the magnitudes of *all* the forces, taken with their proper sign, is nothing, or zero" (Rankine's Civil Engineer, page 140).

From this you deduce

$$C - T = 0,$$

C and T being the sum of the tensile and compressive stresses respectively. Now I conceive this to be an erroneous deduction from the principle and a fundamental error, for it takes *four* stresses to establish this equilibrium, and you have imposed the conditions upon *one-half* instead of on *all* of them. The following is the correct equation:

$$(T - T) + (C - C) = 0.$$

Now, there is nothing in this equation that requires that $T = C$, but only that $T = T$ and $C = C$. The horizontal stresses being *directly* balanced—that is, tension balances tension and compression balances compression—we can impose upon them no other mechanical condition except the equality of their moments.

The principle stated applies to the equilibrium of a *free* body, but a beam is not such a free body, for it is forced to move or rotate transversely around a *fixed* center, with respect to which the moments of *all* of the forces must be in equilibrium. This fixed center cannot be a point within the beam, as it would thus cause the ends of a beam to rotate toward each other around a point within itself, which it is physically impossible for a rigidly connected body to do. Therefore the application of the principle that makes the horizontal stresses an equal force stress couple is erroneous, as it can only be in equilibrio with respect to a point half way between their lines of action.

I could say much more, but fear to trespass too much upon your space. However, I think that you will be convinced that the book deserves a more critical examination than you give it, even though it does apparently contradict all of the text-books and some fundamental principles.

R. H. COUSINS.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(*Continued from page* 325.)

CHAPTER LIV.

COMPARISON BETWEEN THE HAMMER AND THE PRESS.

Large ingots being often not very homogeneous, certain English and German engineers have claimed that forging with the hammer does not correct this want of homogeneity, because the action of the hammer is not felt thoroughly throughout the mass. If this action is very powerful, and is exercised in a very short time, the result is, according to the pretty theory of M. Tresca, that the flowing of the molecules not being produced under the desired conditions, the surface of the metal is changed, while in the hydraulic press the pressure being transmitted almost uniformly to all the layers of the molecules, it follows that they are all submitted to the same work, and thus all disarrangement of the structure is avoided.

We think that this claim is somewhat exaggerated, for after all nothing is less demonstrated than that a piece forged under the hammer under good conditions will have less resistance than if it had been forged in a hydraulic press, the dimensions of the ingot being the same in both cases.

Some engineers have sought to determine the pressure necessary to produce an effect equivalent to that of the shock or blow of the hammer on non-elastic material. They have gone so far as to find a formula after a series of experiments in which they measured or weighed the blow of a hammer-head arrived at the bottom of its fall.

We believe, however, that it is impossible in the full acceptation of the word to weigh or measure the effect resulting from the work of a body which falls freely.

1. On account of the inertia of matter.

2. Because the apparatus which must measure the effect is obliged to pass over a long path in a very short time, and there is a transformation of work with much absorption; what we can obtain is, then, not the exact expression of the work transmitted.

3. If we use as a measure a comparative crushing force there must still be error, for the two causes given above, and also because there is more heat developed in the case of crushing by a blow or a shock—as we will see further on—than when a permanent or steady pressure is applied, and consequently there is more work absorbed.

4. The comparative method is also liable to error, because the effect obtained or work performed is not obtained in the same time by both processes.

When a body of a given weight passes through a certain space in a given time, there is an amount of force developed which can be expressed in kilogramme-meters, and which cannot be compared to the action of an inert body.

To sum up in a word, the work resulting from a blow struck at great speed cannot be compared in its effects with that resulting from a heavy mass moving at a low speed, although they may be equal in one sense.

Let us suppose for instance a hammer of 10,000 kgs. falling 2 meters; the speed of the hammer at the moment when it strikes the forging will be

$$V = \sqrt{2gh} = 6.26.$$

The work produced at the moment of the shock will be

$$T = 10{,}000 \times 6.26 = 62{,}600 \text{ kg.-m.}$$

Admitting a piston speed in the press of 20 mm. per second, the power P should be

$$\frac{62{,}600}{0.02} = 3{,}130{,}000 \text{ kg.}$$

Then this pressure of 3,130,000 kg. should produce in one second an effect equal to that produced in two-thirds of a second by a hammer of 10,000 kgs., having a speed of impact of 6.26, the striking surfaces remaining the same, which is entirely contrary to the truth, taking, for example, the results obtained in England by presses of an inferior power.

In working metals hot it must be remembered that we cannot disregard the influence of the time consumed in producing a given effect, because of the enormous increase of resistance which results from the cooling of the metals, always very rapid at high temperatures, especially when the ratio of the radiating surface to the volume of the forging is large. This influence is especially felt in the case of the press, because the parts next to the press-head cool down very rapidly.

The resistance opposed by a body of metal to any change of form under the action of the hammer or the press cannot be deduced otherwise than by experience, and we have, therefore, made a series of trials in order to determine, if possible, the ratio of power between the hammer and the press, in different conditions as to temperature, quality of metal, and size of forging. Unfortunately, we can only describe these trials, for we have been entirely unable to deduce any formula, which will indicate fully the power of the press capable of producing the same effect as a hammer of a weight and stroke specified, or inversely. In the case of a body submitted to the action of the hammer or of that of the press, a change of figure is produced, which is the result of the displacement of the molecules of this body.

We are going to examine what are the changes produced.

1. If we take a heavy ingot and submit it to the action of a hammer which is too light for the work to be done, it will produce the result known to all hammermen—that is, the surfaces will spread out at the ends, while the central parts will remain intact, the ingot assuming the form shown in fig. 163.

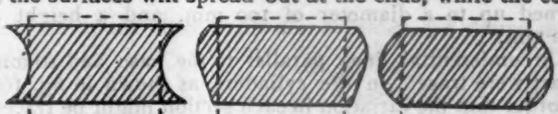


Fig. 163. Fig. 164. Fig. 165.

If, on the contrary, this same ingot is subjected to the action of too heavy a hammer, the central part will spread much more than the surfaces, and it will then take the form shown in fig. 164. This shows that it is necessary, above all, to proportion the effect or blow to the result to be obtained. This is a matter of practice, and the skillful hammerman judges what will be the best way of treating the metal, from its nature, from the size of the ingot, and from the form of the piece which he desires to obtain. The more complicated this form is and the more the changes of section are abrupt the greater will be the difficulty.

If now we take a similar ingot and submit it to the action of the hydraulic press until the decrease of thickness is the same as that obtained in the other two pieces under the hammer, it will take the form shown in fig. 165.

If we break each one of these three ingots through the middle we will see that the exterior layers of the first have a very much finer grain than those in the center; that in the second case the same observation may be made except that the difference in grain between the center and the surface is somewhat less perceptible; which shows that in this case the metal has been worked more at the heart, and consequently presents more homogeneity. The third is, on the contrary, of much finer grain at the center than at the surface.

We can, therefore, conclude from this that the exterior layers have been more compressed by the hammer than by the press, and inversely for the central layers.

An account of the experiments referred to, which presented some very interesting results, will be given in the following chapters.

CHAPTER LV.

EXPERIMENTS WITH THE HAMMER AND HYDRAULIC PRESS.

The experiments, of which notes are given below, were made with a hammer of 3,500 kg., and a hydraulic press made for forging wheels and having a power of 100 tons. It is to be regretted that this was the only hydraulic press

which could be used, for results somewhat different might have been obtained with one having a greater piston speed. The experiments will, nevertheless, serve as a guide to those who are interested in the question, and for this reason it has been considered useful to place them on record.

EXPERIMENT NO. 1 (figs. 166, 167, 168, and 169). Blocks

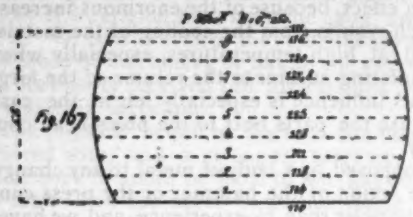


Fig. 167

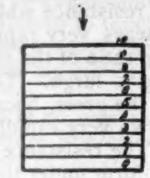


Fig. 166

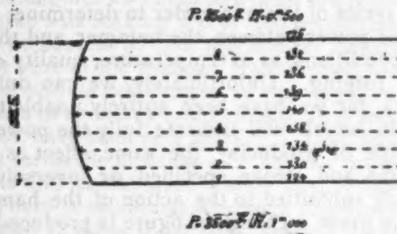


Fig. 168

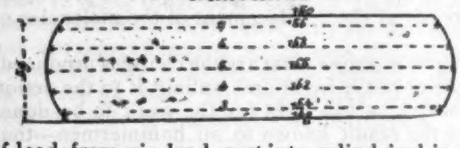


Fig. 169

of lead, from pig lead, cast into cylindrical ingots and then turned up to a diameter of 100 mm. and a height of 100 mm.

Circumferential lines parallel to the base and 10 mm. apart were traced on the cylinders, as shown in fig. 166, in order that the variation in each section might be traced.

1. First block, fall of hammer, $h = 0.250$ meter; thickness, $e = 68$ mm.; compression, $a = 32$ mm. This block is shown in fig. 167. No particular remark required.

2. Second block (fig. 168), fall, $h = 0.500$ meter. The

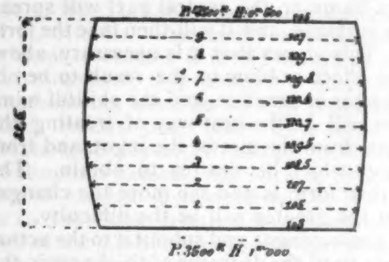


Fig. 170

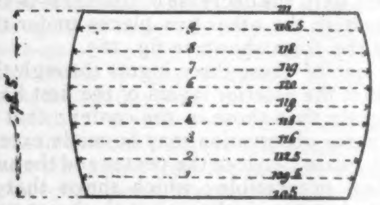


Fig. 171

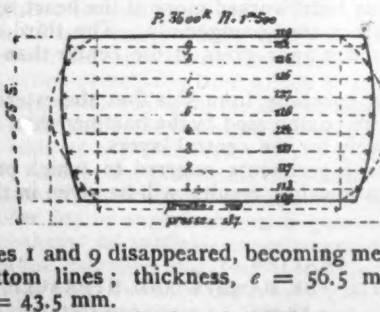


Fig. 172

lines 1 and 9 disappeared, becoming merged in the top and bottom lines; thickness, $e = 56.5$ mm.; compression, $a = 43.5$ mm.

3. Third block (fig. 169), fall, $h = 1.000$ meter; thickness, $e = 39$ mm.; compression, $a = 61$ mm. The lines 1, 2, 8, and 9 disappeared, all the other lines—3, 4, 5, 6, and 7—remaining parallel and almost equidistant.

Three similar blocks were then submitted to the action of the press until their thickness was reduced to that of Nos. 1, 2, and 3 above, respectively, the pressures required being 30 tons, 46 tons, and 79 tons; the changes of form in each case were substantially the same as under the hammer.

If now a coefficient K is sought which would give a ratio between this pressure and the work obtained by the fall of the hammer, we find:

$$K = \frac{P}{p \times h}$$

$$K = \frac{30{,}000}{3{,}500 \times 0.25} = 34$$

$$K' = \frac{46{,}000}{3{,}500 \times 0.50} = 26.3$$

$$K'' = \frac{79{,}000}{3{,}500 \times 1.00} = 22.5.$$

Taking the average of these three results, we have $K''' = 27.6$.

EXPERIMENT NO. 2 (figs. 170, 171, and 172). This was made with cylindrical blocks of steel, 100 mm. in diameter and 100 mm. thick, heated to a clear cherry red—about 1,000° Cent., or 1,832° Fahr.—the blocks being heated in the same furnace and submitted to the action of the two tools—hammer and press—at the same time.

1. First block (fig. 170), fall, $h = 0.500$ meter; thickness, $e = 82.5$ mm.; compression, $a = 17.5$ mm.

2. Second block (fig. 171), fall, $h = 1.000$ meter; thickness, $e = 73.5$ mm.; compression, $a = 26.5$ mm.

3. Third block (fig. 172), fall, $h = 1.500$ meters; thickness, $e = 65.5$ mm.; compression, $a = 34.5$ mm.

All the lines traced on the circumference remained visible, being parallel and almost equidistant, except Nos. 1 and 9, which nearly approached the top and bottom lines, Nos. 0 and 10 in the figures; all the layers increased in diameter, but more at the center than at top and bottom. The greatest diameter is found a little above the middle—that is, between the lines 5 and 6; moreover, the layers exposed to the direct action of the hammer were more ex-

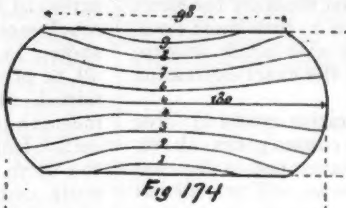


Fig 174

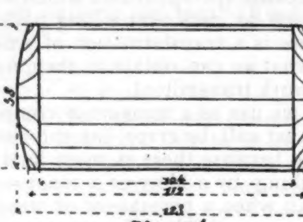


Fig. 176.

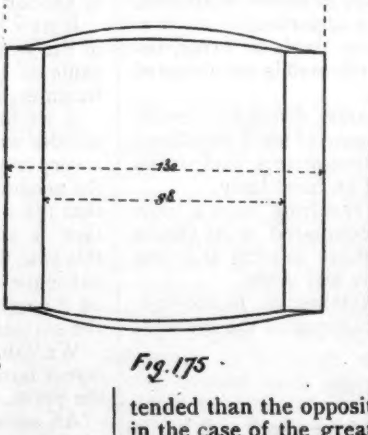


Fig. 175

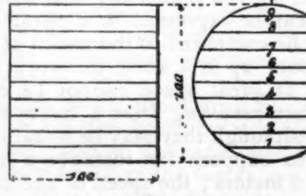


Fig. 173.

tended than the opposite ones, the difference of diameter in the case of the greatest fall—No. 3—being as much as 10 mm.

The three blocks submitted to the action of the press gave, for compressions equal to those tried under the hammer, pressures P equal to 42, 59, and 80 tons, respectively. This gives us coefficients K, equal to 24.0, 16.9, and 15.2, respectively, or an average of 18.7.

It may be noted that the surfaces in contact with the press were not modified, while those in the center were spread or enlarged considerably. In fig. 172 the dotted lines show the form assumed by the block under the press,

with the force of 80 tons, the full lines giving the form of the similar block under the hammer.

EXPERIMENT NO. 3 (figs. 173, 174, 175, and 176). This was made with a cylindrical block of lead 100 mm. diameter and 100 mm. high; weight of hammer, $p = 3{,}500$ kg.; fall, $a = 0.500$ meter; thickness, $e = 58$ mm.; compression, $a = 42$ mm. The horizontal lines 10 mm. apart traced on this cylinder (fig. 173) took after the blow the forms shown in figs. 174, 175, and 176.

A similar block under the press required a pressure of 40 tons to reduce it to the same thickness; the coefficient in this case was, therefore:

$$K = \frac{40{,}000}{3{,}500 \times 0.50} = 22.8.$$

The form of the block under the press was substantially the same as under the hammer.

The force required in the hydraulic press to obtain the same compression was 73 tons; the coefficient K is then as follows:

$$K = \frac{73{,}000}{3{,}500 \times 1.000} = 20.8.$$

In figs. 177, 178, and 179, the full lines show the form assumed by the block under the hammer, the dotted lines showing the form obtained under the press. It will be noted that with the press there was more increase of diameter at the center and less at the surfaces than with the hammer.

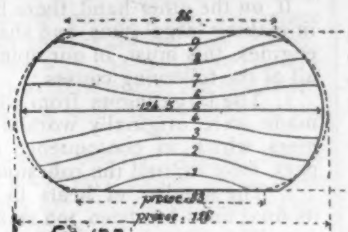


Fig 177.

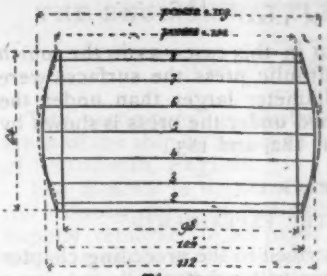


Fig. 179.

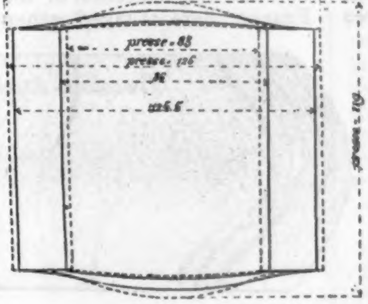


Fig. 178.

EXPERIMENT NO. 5 (figs. 180, 181, 182, and 183). This was made with a block of steel 100 mm. in diameter and 200 mm. long; in order to give a flat surface and even bearing, parallel surfaces 50 mm. wide were planed on the cylinder, as shown in fig. 180, these planed surfaces being 90 mm. apart. The block was heated to a clear cherry red. The hammer acted on this block through two steel blocks 50 mm. square, adjusted to the flat surfaces on the cylinder, fig. 180. The weight of hammer, $p = 3{,}500$ kg.; fall, $h = 1.000$ meter; thickness, $e = 53$ mm.; compression, $a = 37$ mm.

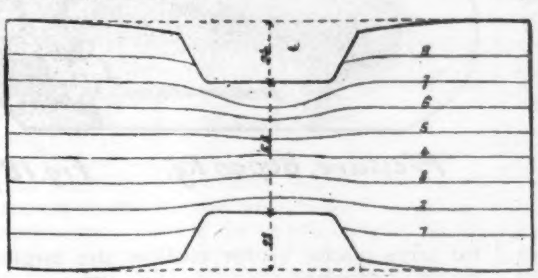


Fig. 181

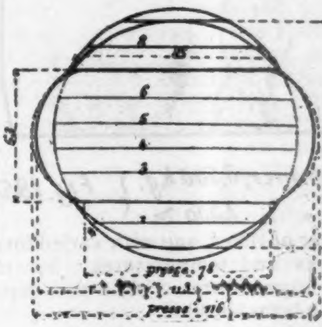


Fig. 183.

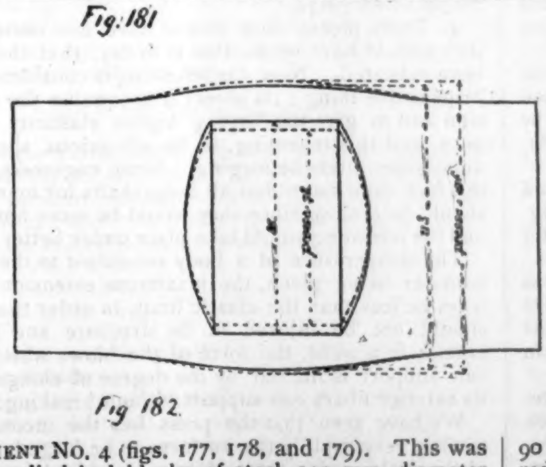


Fig 182.

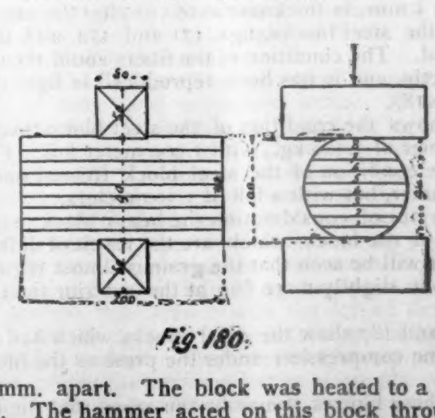


Fig. 180.

EXPERIMENT NO. 4 (figs. 177, 178, and 179). This was made with cylindrical blocks of steel, 100 mm. diameter and 100 mm. thick, heated to a clear cherry red, as in Experiment No. 2. The weight of hammer, $p = 3{,}500$ kg.; fall, $h = 1.000$ meter; thickness, $e = 64$ mm.; compression, $a = 36$ mm.

After the blow of the hammer the lines Nos. 1 and 8 disappeared, and the other lines, Nos. 2–7, followed the curves shown in figs. 181, 182, and 183.

A similar block tried under the press required a force of 53 tons to produce the same compression; the coefficient thus obtained is, therefore:

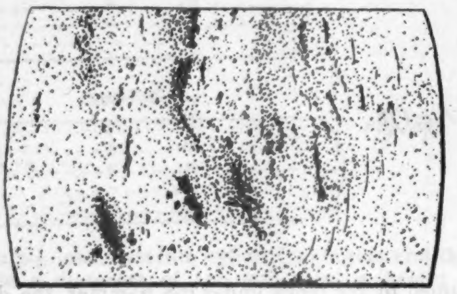
$$K = \frac{53{,}000}{3{,}500 \times 1.000} = 15.2.$$

It may be remarked that in this case—as in the fourth experiment—under the hydraulic press the surfaces were smaller and the central diameter larger than under the hammer. The form assumed under the press is shown by the dotted lines in figs. 181, 182, and 183.

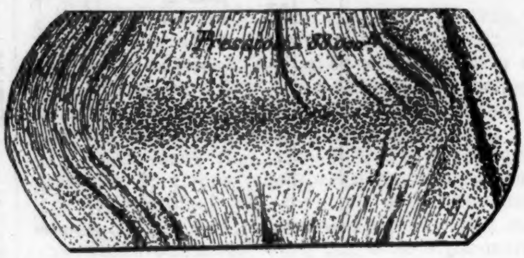
CHAPTER LVI.

REMARKS ON THE EXPERIMENTS.

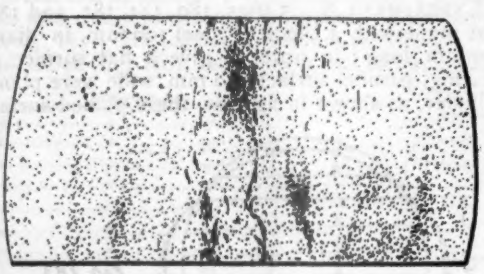
All the experiments described in the preceding chapter were repeated a second time with substantially the same results. To make them complete they should have been repeated a greater number of times, and with varied forms and dimensions of blocks and temperatures; but this would have required an expenditure of time and money which could not well have been afforded.



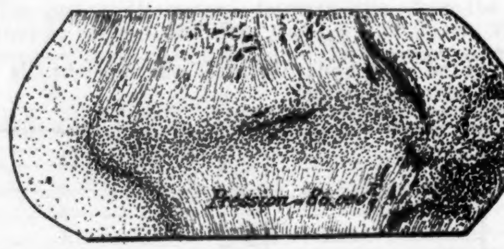
Wt. of hammer, 3,500 kg. } Fig. 184.
Stroke " 1.000 m. }



Pressure, 83,000 kg. Fig. 186.



Wt. of hammer, 3,500 Kg. } Fig. 185.
Stroke " 1.500 m. }



Pressure, 80,000 kg. Fig. 187.

Test pieces 5 mm. in thickness were cut after the experiments from the steel blocks, figs. 171 and 172, and then tried with acid. The condition of the fibers could then be observed exactly, and it has been reproduced in figs. 184, 185, 186, and 187.

Fig. 184 shows the condition of the steel block treated under a hammer of 3,500 kg., with 1.000 meter fall. Fig. 185 shows the condition of the steel block treated under the same hammer, but with a fall of 1.500 meters.

If we leave out of consideration the heavy black marks in the center of the block, which are the result of defects in the ingot, it will be seen that the grain is almost regular throughout, but slightly more fine at the exterior than in the center.

Figs. 186 and 187 show the steel blocks which had received the same compression under the press as the block in fig. 172.

In each of these figures it may be remarked that the exterior fibers have undergone considerable deformation, and that the grain is finer in the center than at the exterior.

From these different trials we can deduce this fact, that in a forging made under the hydraulic press the part which is most compressed and which is strongest is found in the center of the ingot, and if it is bored out—as in the case of large cannon—there is left only the exterior part, which has the least resistance. Now, it certainly appears as if, on the contrary, we should seek to obtain a forging the resistance and strength of which would be equal or nearly equal in all the parts. The hammer preserves the form of the ingot, and works equally on the exterior fibers, and therefore fulfills its object better than the press.

If, on the other hand, there have been faults and failures in making large guns and shafts of large size for marine engines, this must, in our opinion, be attributed to one or all of the following causes:

1. The large ingots from which the forgings have been made were originally worked under double-acting hammers, which, in consequence of their great speed of impact, have injured the cohesion of the steel.
2. The number of heats in bringing the ingot down to its final form has been too small.
3. The ratio between the finished section of the piece and the rough section of the ingot has been too low—in France there is taken generally a minimum ratio of 1:3 for large pieces, 1:5 for medium size forgings, and 1:10 for small forgings.
4. These pieces once forged have not been treated as they should have been—that is to say, that they have not been reheated. Now, the reheating is considered as an indispensable thing; its object is to equalize the interior tension and to give the forging higher elasticity and resistance, and this reheating, to be efficacious, should only be undergone after the forging. Some engineers, relying on this fact, even claim that all large shafts for marine engines should be hollow, since they would be more homogeneous, and the reheating would take place under better conditions.

The temperature of a body submitted to the action of a hammer being given, the maximum extension should always be less than the elastic limit, in order that the metal should not be injured in its structure and should not crack; in a word, the force of the blows which the metal can support is limited by the degree of elongation which its exterior fibers can support without breaking.

We have seen that the press has the inconvenience of cooling very rapidly the surfaces to be forged, on account of the prolonged contact of its cold surfaces, and that this does not take place with the hammer, with which the contact is, so to speak, instantaneous. In consequence the press could not be used for forging pieces with large surfaces and comparatively small thickness; this cooling being too rapid to permit the flowing of the molecules.

One great advantage of the press is that it does not act until the workman is sure that everything is properly arranged ; moreover, the piston can be stopped at any point and any accident or malformation prevented. This cannot be done with a hammer, and thus terrible shocks are often occasioned, which may injure the men working around it and break the crane which carries the forging.

When the press has produced on an ingot a compression corresponding to its maximum power, it can no longer exercise any action upon this piece without a new heating, while with the hammer we can with a second blow produce an additional compression, less than that of the first blow, and we can continue this as long as the temperature of the metal permits.

Presses intended for drawing out and forging ingots should therefore always be made very strong, since those of less power give opportunity for failures, and are in general less economical than hammers.

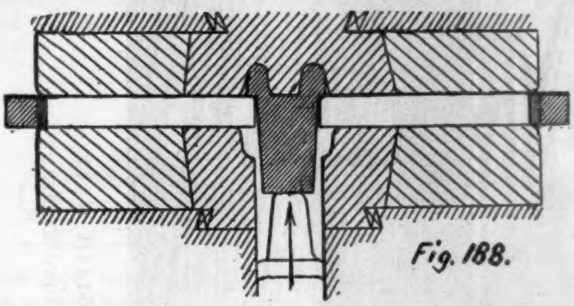


Fig. 188.

When the press is used to forge or stamp iron in closed dies—as in the Haswell or Brunon presses—the preparation of the pile should be made with the greatest care and with a small excess of metal, in such a way as to fill the die completely. These piles are first welded and rough-forged under the hammer into forms which will facilitate their final stamping into shape. The pressure then works on the whole mass and forces the metal to fill all the parts of the die, if its temperature is high enough ; the pieces must have a thickness so great that the cooling effect of the die will not prevent the flowing of the molecules.

In forging iron under the hammer in dies the cinder or slag can escape after each blow, while in the press it is imprisoned in the die and makes the work of finishing more difficult.

One advantage of the press is that the dies, not being exposed to shocks, last longer and their breaking is not to be feared. In working with closed dies the maximum pressure necessary to obtain good work is about 1,500 kg. per square centimeter. This is the power adopted by M. Brunon in forging the hubs of locomotive and car wheels, as shown in fig. 188. The compression pumps work at 100 atmospheres, and the piston of the press being 0.700 meter diameter, the surface is 0.3840 sq. m. The total pressure exercised will then be :

$$3.840 \times 103,300 = 396,672 \text{ kg.}$$

The mandril which penetrates into the die being 0.180 meter diameter, its area is 0.0254 sq. m., and in consequence the pressure per square centimeter exercised upon this mandril and which facilitates the flowing of the molecules from the center to the circumference is :

$$\frac{396,672}{254} = 1,560 \text{ kg.}$$

This pressure would be sufficient to stamp out hubs of 0.350 meter diameter.

In stamping out pieces of steel, as the resistance of that metal is greater than that of iron, and as it is worked at a lower temperature, the pressure per square centimeter should be twice as great, or about 3,000 kg.

In the Brunon press the upper, or male, die, which is worked by a screw, has a speed of 30 mm. per second and serves to close the lower, or female, die. The piston of the press then acts and raises with a speed of 40 mm. per second. The upper die stops as soon as it strikes the work, and it is at that moment that the piston of the press exercises its power and forces the hot metal into all the recesses of the die.

(TO BE CONTINUED.)

THE ENGLISH BATTLE-SHIP "BENBOW."

(From the London *Engineer*.)

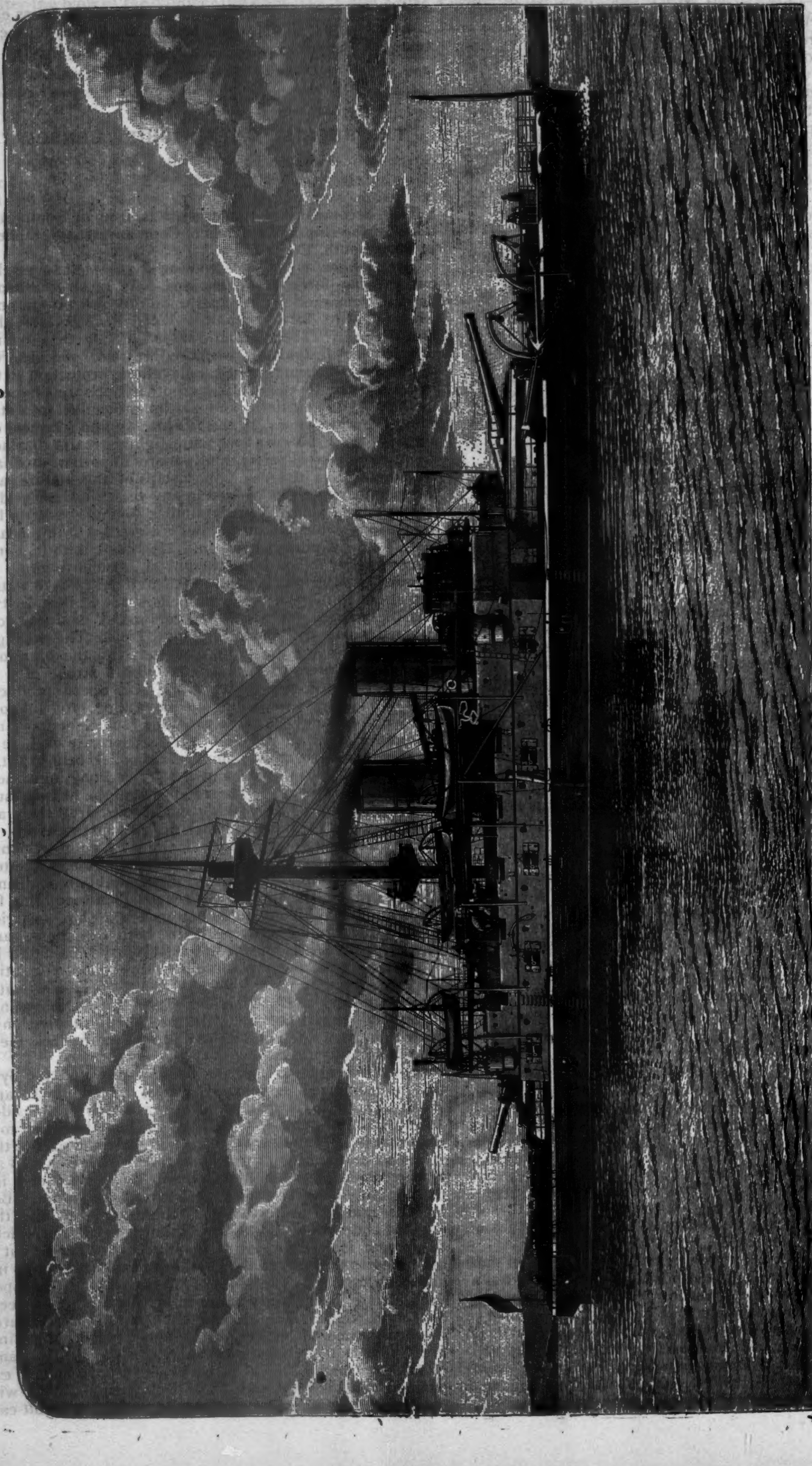
THE accompanying illustration is from a photograph taken of the ship by Symonds & Company, photographers, of Portsmouth, England.

The *Benbow* is the most powerful completed vessel in our existing force of battle-ships. As Lord Armstrong happily remarked in his paper upon the new programme, which appears in this month's *Nineteenth Century*, they are advisedly called "battle-ships." For they cannot properly be designated "armored vessels," because the armor, as at present applied, only affords protection to the hydraulic loading gear, lifts, and other apparatus beneath the heavy gun positions, and partial protection to a strip along the water-line. In the *Benbow* we find a typical example of the *Admiral* class, with slightly greater displacement, more coal capacity, and a more important auxiliary armament than the remaining ships of this nature, and the two heaviest guns carried in any vessel in the world.

The ship is almost exactly similar to the *Anson* in her dimensions, which are as follows : Length, 330 ft. ; beam, 68 ft. 6 in. ; depth, 37 ft. 1¼ in. Her draft is 28 ft. 4 in. ; displacement, 10,600 tons ; height of freeboard, about 10 ft. 6 in. ; and height of center of heavy guns above water-line about 20 ft. The twin propellers are worked by two sets of inverted three-cylinder compound engines, constructed by Messrs. Maudslay, Sons & Field. The two high-pressure cylinders are 52 in. diameter, and the four low-pressure cylinders 74 in. diameter, with a stroke of 3 ft. 9 in. The indicated H. P. is 11,500. Speed produced with forced draft, according to patent log, 16.75 knots. The coal capacity is for 1,200 tons, sufficient for 7,100 miles at a speed of 10 knots. The boilers are oval, 12 in number, arranged athwartships, each boiler being 12 ft. 4 in. wide, 14 ft. 1 in. high, and 9 ft. 11 in. long, and there are in all 36 furnaces. The total area of the heating surface is 20,440 ft. For working with forced draft there are eight fans of 5 ft. diameter, each driven separately.

The hull of the *Benbow* is divided into 190 compartments, and the magazines are at either end beneath the barbettes, connected with them by an armored ammunition trunk. There is room in them for 180 rounds of ammunition for the heavy guns. The double bottom of the ship is carried beyond the citadel bulkheads in both directions, and further protection is afforded against injury from below by a water-tight platform over the hold throughout the entire length of the ship, and between this and the under-water shot-proof deck are the boilers, engines, and magazines of the big guns. In effect, the method of subdivision is such that from the hold right up to the main deck there are practically three skins.

Protection against shot and shell is provided for by a belt of steel-faced compound armor, 18 in. thick, and about 150 ft. in length, so placed as to cover the sides amidships to a depth of 5 ft. below the load line, and to a height of 2 ft. 6 in. above the water. Over the part of the vessel so defended against horizontal fire there is also an armored steel deck, built up of two thicknesses of ½ in. plating and one layer 2 in. thick, making 3 in. in all. Below the 'midship protective deck there is placed over the engines and boilers a light steel splinter deck, ⅜ in. thick, to prevent interference with the forced draft and shut it off. Across the ends of the citadel are bulkheads of 18 in. and 16 in. armor. The sides of the ship above the upper deck, where the auxiliary batteries are placed, are of steel, only 1 in. thick. The sloping ends of this battery are, however, armored with 6 in. plate, to prevent a raking fire. This is the one fatal weakness of the *Benbow*, and of all her class. The 1 in. plate is just sufficient to explode a shell charged with high explosive, so that it will discharge its contents between decks, with what result can

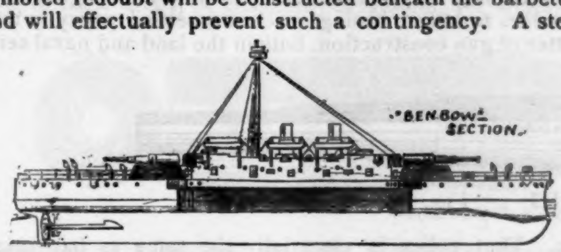


FIRST-CLASS BATTLE-SHIP "BENBOW" ENGLISH NAVY.

BUILT BY THE THAMES IRON WORKS & SHIPBUILDING COMPANY.

be too easily anticipated. When the coal bunkers along the sides of the ship below the armored deck are filled they oppose a thickness of about 9 ft. of coal to the passage of shot. On the lower deck, in front of the horizontal water chamber—introduced to check the rolling of the ship by the movements of a large weight of water freely flowing from side to side—there are four deep water-tight tanks, to hold the ship's cables.

The two barbettes each cover a space on the upper deck about 45 ft. by 60 ft., the plan being pear-shaped, so as to leave room for the protection of the loading gear. They have steel-faced armor, 14 in. thick upon the exposed portions, and 12 in. thick behind the screens. An armored ammunition trunk, before mentioned, 10 ft. across, plated 12 in. thick, provides for the safe lifting of the powder and shot from the magazines below to within each barbette. But this armored stalk to the barbette does not permit the possibility of a shell bursting beneath the entire gun position and wrecking it. In the new barbette ships a heavily-armored redoubt will be constructed beneath the barbette, and will effectually prevent such a contingency. A steel



wire rope, working through the ammunition hoist, raises the projectiles for the heavy guns which weigh 1,800 lbs., and the charges, 960 lbs., in two portions. Overhead railways run the projectiles along from the magazines to the bases of the hoists.

The armament consists of two 111-ton steel breech-loading guns, one in either barbette, having a muzzle velocity of 2,100 foot-seconds, and a penetrative power into 32.5 in. of armor-plate at 1,000 yards. This would pierce the central citadel of the *Inflexible*, clothed with the thickest armor afloat. The auxiliary armament consists of ten 6-in. steel breech-loading guns, having a power of penetration into 10.3 in., which would dispose of either turtle-back deck plating, or any of the protective arrangements made for the lightly-armored cruisers now under construction. There are also fifteen 6 and 3-pounder Hotchkiss, and seven machine guns, and a proportion of torpedo discharge tubes. These last are fixed, as in all vessels of the *Admiral* class, on a special deck beneath the broadside batteries. They are capable of any amount of training, by means of the ball-and-socket joints with which they are worked in the sides of the ship.

On the spar-deck the *Benbow* carries a second-class torpedo boat, as well as a very large proportion of pinnaces and launches. The conning-tower is protected with 14-in. armor. The steadiness of this ship as a gun platform is very remarkable in ordinary weather. But the concentration of the armor plating so much toward the center, and the shortness of space between the gun positions, involves a bad distribution of the weights.

THE DRY-DOCKS OF THE WORLD.

FROM an article on Sheathed or Unsheathed Ships, by Naval Constructor Philip Hichborn, U.S.N., published in the last number of the *Proceedings* of the United States Naval Institute, we take the following interesting statements in relation to the dry-docks of the world :

It may be of interest to the general reader to know the extent of the "multiplicity of dock-yards" and private docks all over the world. It will, with the aid of a Mercator's Atlas, be easy to show how few and far between are the facilities for docking upon the ocean highways, where vessels of the United States Navy, especially cruisers, could go in to scrape and paint bottoms. It would, of course, be useless for this country to send its ships-of-war into European waters, where they would be picked up by overwhelming numbers of the enemy's ships, if the war was with either England or France.

The hostile operations would therefore be limited to within a few hundred miles of our own coast upon the Atlantic and the Pacific, and to an occasional brief cruise to the West Indies, while the paint upon the cruiser's bottom was still fresh. On the Atlantic Coast the Government docks are limited to Portsmouth, N. H., one floating dock ; New York, one stone dock, and a timber dock now building ; and at Norfolk, one stone dock, and a timber dock (building).

Of the projected docks no account has been taken in the following tabulated statement, which gives the distribution of the dry-docks of the world :

Austria	5	Russia	7
Belgium	11	Spain	13
Denmark	4	Sweden	13
France	53	Turkey	4
Germany	31	Africa	6
Great Britain	265	America	88
Greece	1	Asia	60
Holland	17	Australasia	12
Italy	13		
Norway	9	Total	616
Portugal	4		

Of the 166 docks in Africa, America, and Australasia, 87 are owned by the governments or citizens of European countries, as follows : Great Britain, 78 ; France, 6 ; Holland, 1 ; Portugal, 1 ; Spain, 1 ; total, 87. Of those owned by Great Britain 2 are in Africa, 15 in America, 51 in Asia, and 10 in Australasia.

Thus revised, the number of docks owned at home and abroad by the different countries is :

NATIONS.	At Home.	Abroad.	Total.	Gov't. Docks.*
Austria	5	...	5	2
Belgium	11	....	11	2
Denmark	4	....	4	2
France	53	6	59	32
Germany	31	....	31	8
Great Britain	265	78	343	42
Greece	1	....	1	1
Holland	17	1	18	2
Italy	13	....	13	8
Norway	9	....	9	3
Portugal	4	....	5	1
Russia	7	...	7	7
Spain	13	1	14	7
Sweden	13	....	13	6
Turkey	4	....	4	4
United States	60	....	60	6
Peru	1	....	1	1
Chile	2	....	2	2
Argentine Republic	4	....	4	....
Brazil	4	....	4	2
China	3	...	3	3
Japan	5	....	5	2
Total	529	87	616	143

From the foregoing table it appears that Great Britain controls or owns nearly 56 per cent. of all the dock-yards of the world. It has 10 in Australia, 15 in China, 36 in India and the adjacent islands. It owns 2 in Africa, 12 in Canada and British Columbia, 2 in the West Indies, 3 at Malta, and 1 at Demerara. The other 262 docks are within the confines of England, Scotland, and Ireland.

Let the reader follow the course taken by a cruiser from the Brooklyn yard, bound for the Pacific to protect American shipping or to chase and capture the enemy's vessels. The rendezvous of this cruiser would naturally be the Mare Island Navy Yard, so often referred to in each report of the Secretary of the Navy. Here the cruiser would call in to be docked for cleaning and painting, something quite necessary after a voyage of 15,000 miles. The cruiser would, of course, stop at Rio Janeiro to coal, and perhaps to dock, there being three docks of sufficient size to accommodate a ship of from 3,000 to 5,000 tons displacement. At Montevideo, 1,200 miles farther south, or 7,300 miles from New York, there are docking facilities for vessels not drawing over 18 ft. But after this there is no oppor-

* Included in total.

tunity to dock until San Francisco is reached, for all the docks on the west coast of South America, at Valparaiso and Callao, three in number, range only from 1,500 to 2,500 tons lifting capacity.

Once safe on the coast of California, the cruiser would have the choice of only two localities for docking to scrape and paint her bottom, namely, at San Francisco (or Mare Island) and Portland, 800 miles farther north, the latter within close proximity to the British naval establishment at Esquimault, Victoria, B. C. The docking facilities at Mare Island consist of one stone dry-dock, large enough to accommodate any war vessel except the large Italian armor-clads and those of England. Another dock at Mare Island built of timber, has been in use since 1853 and is rapidly decaying. The docks at San Francisco are the dry-docks at Hunter's Point, of a nearly similar capacity to that at Mare Island, and the hydraulic dock of the Union Iron Works, capable of lifting a vessel of about 3,000 tons displacement.

In Government docks the sole expense is that of the labor to prepare the dock and take the ship in and out. For a vessel like the *Chicago*, the cost would be between $300 and $400 for docking alone. To this sum must be added about $1,000 for scraping and painting, making a total of about $1,400. The actual cost of docking and painting the *Atlanta* is $1,250.

It is something quite different when a private dock is engaged. In Great Britain, great competition has brought the charges down to a minimum, but the docks in India, China, Australia, and on the Pacific Coast are very expensive. A few years ago, at San Francisco, the docking of the French ironclad *Triumphante* cost about $15,000 for five days, and when another French ship, the *Duquesne*, required docking in November last, the private dock wanted $5,000 for the first day and $2,500 for each additional lay-day. It would therefore appear that docking is an expensive operation, at least in the waters to which our ships-of-war would be confined in war time, and, moreover, that sometimes it might not be had at any cost, except at a few home ports.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

BY LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.

(*Continued from page 322.*)

VII.—NAVAL ORDNANCE—CONVERTED GUNS.

THE work of converting our naval smooth-bore ordnance began in 1875, by the conversion of 11-in. shell guns into 8-in. muzzle-loading rifles, upon the same general system as has been followed in the land service—the insertion of a wrought-iron tube from the muzzle. The *Trenton*, which went to the bottom the other day in Samoan waters, was the first vessel to receive a complete rifled armament. A number of Parrott guns were also converted. In 1880 a 300-pounder, 10-in. Parrott was converted into a 9-in. breech-loader, by the insertion of a steel-jacketed, wrought-iron tube.

In 1882, when the rehabilitation of the Navy began, we find the rifled ordnance of the Navy to consist of one hundred and three 40-pounders, two hundred and seventy-seven 80-pounders, and fifty-one 180-pounders, all converted. Of this number twenty-six were breech-loaders.

The naval appropriation bill of August 5, 1882, authorized the building of four new cruisers, with their necessary armament of modern guns. Designs for 5, 6, and 8-in. breech-loading rifles were made, and later for guns of 10, 12, and 16-in. caliber. The first 6-in. gun was finished and turned over for trial in 1884. In the same year contracts were made with the English firms of Whitworth & Company and Cammell & Company, for the steel tube and jacket forgings for 8-in. guns. All the forgings for the smaller calibers, and the hoops for all calibers being obtained from American manufacturers.

The work of assembling and finishing began at the Washington Navy Yard, but its capacity being limited, contracts for a part of this work were made with the South Boston Iron Works and the West Point Foundry Association.

The first 8-in. Navy gun was finished in 1886. The year following the first 10-in. was turned over for trial.

Under the stimulus of liberal appropriations and the assurance of Government orders, the steel-makers of the United States are now, or soon will be, prepared to make all the forgings for guns up to 16-in. caliber. The Bethlehem Iron Company alone has spent a million and a half upon its plant for steel fabrication. We can congratulate ourselves in at last having reached a settled policy in the matter of gun construction, both in the land and naval service. That policy is essentially the same as has been adopted in France—to procure the rough forgings from private foundries and assemble and finish in Government shops. For the present, at least, and probably for some years to come, the necessities of the country and the limited facilities of the Government shops will lead to a very considerable part even of the latter work being done by private firms. The forgings delivered at Government shops are required to be oil-tempered and annealed. All work done at private shops is under the constant supervision of an ordnance expert.

8-inch Navy Rifle, Mark III Fig. 4.

In 1887 the Washington Navy Yard was transferred to the Naval Ordnance Bureau, and is now known as the Naval Gun Factory. When the present alterations are completed its yearly capacity will be equal to the completion of twenty-five 6-in., four 8-in., six 10-in., and four 12-in. rifles, or a proportionate number of other calibers.

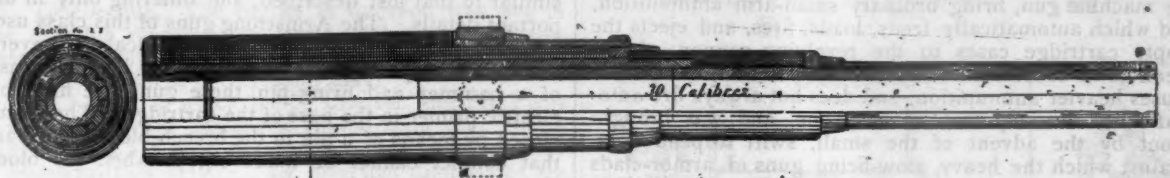
The 14-ton, 8-in. Navy rifle of the last model may be taken as a type of naval ordnance construction, the details of which are shown in fig. 4. (It should perhaps be said that in plates given in these articles no attempt has been made to draw them to a common scale.)

With the beginning of the present year the United States possesses, in the way of high-power naval ordnance, actually finished, two 5-in., twenty-four 6-in., eight 8-in., and three 10-in. steel breech-loading guns, all made of open-hearth steel.

The endurance and ballistic qualities exhibited by these guns have been very satisfactory, and they are believed to be, in this respect, the equals of any guns of like caliber made abroad. But they have, we believe, one very grave defect, and that is in the matter of breech-mechanism. Both Army and Navy guns alike have the French, or interrupted-screw fermatures. Mention has already been made of the defects and dangers of this system. The fact cannot be too strongly emphasized that it has been a failure from the beginning. Our own brief experience points in the same direction. The accidental spiking of one of our new Navy guns before it left the workshop; the recent blowing out of the breech-block of one of our new breech-loading mortars at Sandy Hook; the complaints as to "sticking" in our field-guns, are but the beginning, we believe, of greater and more serious accidents. One of our own service papers, speaking on this subject, says: "When French field-guns unbreech even with blank cartridges, and then the heaviest guns either unbreech, or, when this defect has been corrected, the whole breech is blown off in ordinary service firing, it may reasonably be held that the system is at fault through inherent weakness, and, being unsafe, must at once be condemned out of hand."

It should be said, however, that our application of the screw fermature is an improvement on the French construction. As applied by them the seat of the breech screw is in the gun-tube itself; in our construction, both Army and Navy, the jacket carries the breech mechanism. While this reduces the danger it does not do away with the other objections that have been urged against the system.

The Board on Heavy Rifled Ordnance, created by the Act of 1872, recommended the Krupp breech-loading system. As has been stated, an 8-in. and an 11-in. converted breech-loading rifle, with the Krupp fermature, were tested in October, 1881. The 8-in. burst tangentially at the 127th round, the gun flying into many pieces, showing general weakness of metal; the 11-in. burst at the 18th round, fracture taking place at the junction of the breech-block slot with the powder chamber. The Board reported the accident due to "an inferior quality of steel in the breech-receiver." So far as can be seen there was nothing in these trials to condemn the system, yet when the designs for the new built-up guns were made adherence was given wholly to the French screw, and has ever since been persisted in.



Woodbridge's 10-inch Steel Wire-wound Rifle. Fig. 5.

VIII.—WIRE-WOUND GUNS.

Another system of gun construction, which is about to receive trial in the United States, is that of wire-wound guns. The possibilities in this method of construction seem so great that it is worthy of mention, although still in an experimental stage. Generally speaking, the system consists in winding about the body of the gun layers of steel wire, under a known tension. The result, so far as concerns the inner tube, or bore of the gun, is to put it in a state of initial tension, under exactly the same conditions as when the piece is built up in the ordinary way by shrinkage. As it is possible to regulate the tension of the wire during the process of winding with exactness, it can be readily seen that almost any degree of initial tension for the inner portions of the gun can be obtained. The great defect in all guns of this construction is the want of end, or longitudinal strength.

This method of strengthening guns by winding the body with steel wire was first proposed to the British War Office, in 1855, by Mr. James A. Longridge. After some experiments, which demonstrated that while great circumferential strength was obtained, there was an equally great lack of longitudinal strength, the idea was, for the time, abandoned. Sixteen years later (1871) Lieutenant Schultz, in France, revived the idea, and a gun was constructed in which the body, a steel tube, was wrapped with steel wire, and encased in a wrought-iron jacket. Longitudinal strength was provided for by 12 long bars of steel set up between two bands shrunk over the jacket, one carrying the trunnions and the other enclosing the breech mechanism. The gun burst at the first fire, owing, it is said, to the unequal tension of the longitudinal bars. Other trials were made with cast-iron bodies, tubed with steel as far as the trunnions, and wrapped as before. In the later constructions the longitudinal bars were abandoned and end strength obtained by a jacket shrunk on over the wire, the jacket in front hooking over a band already shrunk on the gun, and at the rear being notched into the band containing the breech mechanism. Experiments in France have been carried on interruptedly since, with a gradual improvement in the methods and material employed. In 1886 a 13.3-in. wire-wound gun was finished for the Navy, from which an initial velocity of 2,300 feet-seconds was obtained.

Some years ago Sir William Armstrong took up the idea of wire-wound guns in England, which had been abandoned by Longridge, and manufactured several experimental pieces, and obtained results so satisfactory that this system of construction promises to obtain a secure footing in that country. A 10.2-in. gun was first manufactured, in which longitudinal strength was obtained by the disposition of some of the wire lengthwise around the tube. Armstrong has also manufactured a 6-in. gun in which a jacket is made to provide for longitudinal strength, the wire wrapping being expected to bring only circumferential strength.

The Royal Gun Factory has also taken up the subject and designed a system for experiment on a large scale. Longitudinal strength is obtained by means of segmental hoops of steel placed between the layers of wire. With a 9.2-in., 19-ton gun they have been able to use a charge of powder almost equal in weight to the projectile. A 375-pound charge threw a 380-pound shot with a muzzle velocity of 2,520 feet-seconds.

The Russians have also turned their attention to wire construction, and something over a year ago their first gun, constructed at the Aboukoff Steel Works, on Mr. Longridge's principle, was successfully tested. The gun is 6-in. caliber, 35 calibers in length, and has its steel tube wrapped for a little more than half its length with steel ribbon wire, which has a cross-section of 0.252-in. wide and 0.059 in. thick. Up to last reports this gun had been fired 300 rounds. The maximum velocity obtained was 2,150 ft., with pressure of less than 16 tons.

In the French construction round wire is used, of two sizes, for large and small calibers, while the English use ribbon wire. A patent has been recently obtained in England for a peculiar form of corrugated wire for gun construction. The exterior of the gun body has a corrugated surface. Into these corrugations the first layer of wire fits. Each layer of wire fits into the corrugations of the preceding one. The last layer has a flat exterior surface which gives a smooth exterior to the gun. The grip of the corrugations is expected to give the necessary longitudinal strength.

In the United States Longridge's claim to priority in the idea of wire-wound guns is disputed by Dr. W. E. Woodbridge. Dr. Woodbridge's plan was brought forward in 1850, or five years before Longridge's plan was submitted to the British War Office, and to him undoubtedly belongs the honor of the invention.

Woodbridge's system of wire-wound guns differs from that of Longridge's in that the wires, after being wound, are soldered together by immersing the gun in a bath of melted solder, the object of the solder being not only to give longitudinal strength, but also to prevent the unwinding of the wire in case a strand were cut by a hostile shot or otherwise. A 10-in. gun of this description was finished at the Frankford Arsenal in 1876 for trial. Square wire was employed, wound upon a solid steel core, which was afterward bored out to the required diameter, leaving a thin tube to form the bore of the finished gun. The piece failed during test from longitudinal weakness, after having been fired some 90 odd rounds with moderate charges.

The Heavy Ordnance Board, organized in 1881, recommended the further trial of the Woodbridge system. Under this recommendation a 10-in. cast-iron body, wrapped with wire, and one of steel of the same caliber are now in course of construction by the Army Ordnance Department, at the Watertown Arsenal. The cast-iron gun is well along toward completion. In this gun the wire has a square cross-section of 1.5-in. with rounded corners, and is wound with a uniform tension of 41,000 lbs. per square inch. The wire is supposed to have a tensile strength of 160,000 lbs. per square inch, and an elastic limit of 100,000 lbs.

The details of construction of the 10-in. steel gun are shown in the accompanying cut, fig. 5. Longitudinal

strength is obtained by a layer of long, square steel bars, with a cross-section of 3.43 in.

In 1882 two 6-in. wire-wound naval guns were authorized. Their construction was begun at the Washington Navy Yard, but has never been completed.

The advantages claimed for this method of construction are that a wire-wound gun can be completed in much less time than a built-up gun of the same caliber; that they are cheaper; possess greater strength, and afford a saving of some 25 per cent. in the weight of the finished piece.

IX.—RAPID-FIRE GUNS.

Within the last two years what are known as rapid-fire guns have reached a stage of development, both as regards weight of projectile and velocity, as to entitle them to be classed as high-power ordnance.

The real prototype of the rapid-fire gun was the well-known French *mitrailleur*, of which so much was expected and so little realized in the Franco-German war. From the machine gun, firing ordinary small-arm ammunition, and which automatically feeds, loads, fires, and ejects the empty cartridge cases to the revolving cannon, almost identical in construction and in manipulation, except that it uses heavier ammunition, and does not always fire automatically, the step was an easy one, and was brought about by the advent of the small, swift torpedo boat, against which the heavy, slow-firing guns of armor-clads gave but poor protection, and placed the heavier war-ship at the mercy of a lively but insignificant foe. The revolving, or machine cannon, firing projectiles of from one to four pounds in weight at the rate of from 20 to 80 shots per minute, with sufficient power to penetrate the sides or the armor-plating of these agile craft restored the equilibrium.

The rapid-fire gun differs from the revolving cannon or the machine gun in that each round, containing projectile, charge, and the fulminate for its ignition, is contained in a metallic case and must be handled separately. It is automatic only in the ejection of the empty cartridge-case and the cocking of the piece by the opening of the breech after firing. Beginning with the 3-pounder gun the growth has been rapid, until we have reached a stage when the weight of projectile and its power of penetration entitle the larger calibers to be classed with high-power ordnance.

Of guns that may be so classed there are the 36 and 100-pounder Armstrong; the 33-pounder Hotchkiss, and the 40 and 66-pounder Krupp. The 36-pounder Armstrong (caliber 4.72 in.) with a 12-pound charge and a 45-pound projectile, has given a muzzle velocity of 2,380 ft. per second, capable of penetrating some 9½ in. of wrought-iron, and has a rapidity of fire of 12 shots per minute. It has fired 10 shots in 47.5 seconds. The 100-pounder (caliber 6-in.) has a 45-pound charge, a projectile of 110 pounds, which will penetrate 15½ in. of wrought-iron, and can be fired 8 times per minute. The 33-pounder Hotchkiss (caliber 4 in.) uses a 12.5-pound charge, a 33-pound projectile, and has given a muzzle velocity of 2,034 feet-seconds, with a penetration of 10 in. The Krupp 10.5 and 13 centimeter guns, with projectiles of 40 and 66 lbs. respectively, can be fired from 12 to 15 times per minute, but the published accounts of their capabilities show a velocity and penetration considerably less than those given by either the Armstrong or Hotchkiss rapid-fire guns.

The employment of revolving cannon and rapid-fire guns as secondary batteries to men-of-war has obtained for several years. The development of the rapid-fire gun has now made it possible to employ them as main batteries for unarmored cruisers and vessels of the smaller type. The Italian cruiser *Piemonte*, built last year by Sir William Armstrong, carries six 4-in. and six 6-in. rapid-fire guns in main battery. All the later types of English cruisers are to be provided with this class of guns. As they have a rapidity of fire of from four to six times that of the ordinary breech-loading cannon of like caliber, the immense gain of such an armament is apparent. At Suakim, in December last, the rapid-fire guns on the *Racer* and *Starling* did splendid service in seconding the English attack.

The breech mechanism of rapid-fire guns merits a word of description. The Hotchkiss may be taken as a typical arm. In it the breech-block belongs to the wedge system, working in a vertical slot and falling downward of its own weight, exposing the bore. The block itself is rectangular in its cross-section with rounded corners. The front of the block is perpendicular to the axis of the bore, the rear face slightly conical. The breech-block is worked by means of a crank, with handles pivoted on the right side of the piece. It carries the firing mechanism. By pulling the crank-handle to the rear the block is disengaged from its seat and falls of its own weight. This movement of the crank-handle cocks the hammer, and the falling of the breech-block actuates an extractor for throwing out the empty cartridge-case. The block is arrested in its downward movement by a stop-bolt screwed through the left side of the breech and into a slot cut in the left side of the breech-block. The piece is fired by means of a lock and hammer like those used on an ordinary rifle, and, like it, is provided with a trigger and trigger-guard, and a pistol grip.

The mechanism of the Krupp rapid-fire guns is very similar to that just described, and differing only in unimportant details. The Armstrong guns of this class use the ordinary interrupted screw, made conical, however, to facilitate the opening and closing of the breech. Instead of a hammer and firing-pin, these guns are fired by an electric primer in the base of the cartridge. The circuit is closed by means of a pin in the breech-block, so arranged that contact cannot be made except when the block is closed and secured in position.

It seems likely that the limit of caliber of these guns has about been reached. It has been questioned whether a projectile heavier than one man could easily lift would not nullify the advantages claimed for this class of guns. With the 100-pounder Armstrong gun a round of ammunition can be handled by two stout cannoneers. Beyond this weight it seems difficult to go, since any additional increase would necessitate the employment of mechanical means for handling the ammunition, which would then give them little, if any, advantage over an ordinary breech-loader.

The 6-pounder Driggs-Schroeder gun, the invention of two United States naval officers, has recently been tried at the Naval Proving Grounds, with such results as to give promise that it will be a very successful rival to other systems. Designs for a 5-in. gun are in preparation. The advantages claimed for this system are the extreme lightness of the breech mechanism—its weight being but about half that of the Hotchkiss—and the fact that it is simple and entirely protected by the breech-casing from rain and dust, the opening being from underneath.

The entire main batteries of the three 2,000-ton steel protected cruisers, authorized by the last Congress, are to be of rapid-fire guns—two 6-in. pivot and eight 4-in. broadside guns for each, besides their secondary batteries of 3 and 6-pounder rapid-fire and Gatling guns.

In following the development of the modern high-power gun no mention has been made of many of the numerous designs and systems of construction proposed by private firms and individuals both here and abroad. The list of those which have been unsuccessfully tested in the United States is a long one. Hitchcock, Mann, Sutcliff, Thompson, Wiard, Atwater, and Lyman-Haskell are names familiar in connection with ordnance experiments during the past 25 years. Of them all the Lyman-Haskell seems to be the only one which still claims sufficient merit to warrant a suspension of judgment. This is a multi-charge gun, in which the charges, arranged in a series of pockets along the bore, are successively exploded behind the projectile as it passes out of the piece. This system has had many trials, and a large amount of private capital has been expended upon it. Whether its failure has been due to poor material in the guns, or to a defective system of rifling, as is claimed by Mr. Haskell, or to inherent weakness of the system itself, will have to be determined by further experiment.

It is undoubtedly true that the efforts of private individuals and firms in the line of ordnance invention have been received by our official gun-makers with indifference, if not hostility. The success of Whitworth in England and Krupp in Germany shows what can be done by private enterprise in the line of ordnance invention and construc-

tion. In the first instance success was attained in spite of official discouragement and opposition ; in the second Government aid and encourgement have been freely given.

Whether or not prejudice has operated unfairly against private enterprise in this direction in the past, it is quite certain that under present conditions there will be "a fair field and no favor."

(TO BE CONTINUED.)

A FRENCH COMPOUND LOCOMOTIVE.

(From the *Revue Generale des Chemins de Fer.*)

AN application of the apparatus invented by M. de Landsee was made in November, 1885, on a locomotive of the Northern Railroad of France, under the direction of M. Banderali, Chief Engineer of Material and Traction, to whom the test was committed, by the Engineer-in-Chief, M. E. Delebecque. The engine in question was one of those used for running light trains. This condition was necessary so that it might be run at all times with direct admission of steam to one cylinder only.

Engine No. 79, to which the de Landsee apparatus was applied was an old passenger engine, with four wheels coupled, which had been changed to a tank locomotive for the tramway-train service. Its principal dimensions are given in the table below :

Grate surface....................	9.47 sq. ft.
Heating surface, fire-box..........	51.67 " "
Heating surface, tubes............	726.70 " "
Heating surface, total.............	778.37 " "
Capacity of the boiler, water.......	61.80 cub. ft.
Capacity of the boiler, steam.......	46.61 " "
Diameter of cylinders............	15 in.
Stroke of cylinders................	22 "
Diameter of driving-wheels........	68½ "
Diameter of leading-wheels........	41 "
Weight of engine in running order.	67,000 lbs.
Weight on driving-wheels.........	46,050 "
Maximum theoretic tractive effort..	5,122 "

The total weight of engine given above includes the tank full of water and 1,100 lbs. of coal.

In the accompanying illustrations fig. 1 is a general elevation of the engine ; fig. 2 is a front view, and fig. 3 a plan of the smoke-box, showing the arrangement of the steam and exhaust-pipes ; fig. 4 is a section of the steam-chest, showing the position of the valve when steam from the boiler is admitted to both cylinders, and fig. 5 is a section showing the position of the valve when steam from the boiler is admitted only to the high-pressure cylinder. It must be understood that the de Landsee apparatus is an arrangement by which the engine is worked on the compound principle with the ordinary cylinders—that is, with two cylinders of the same size. Steam can be admitted

Fig 2.

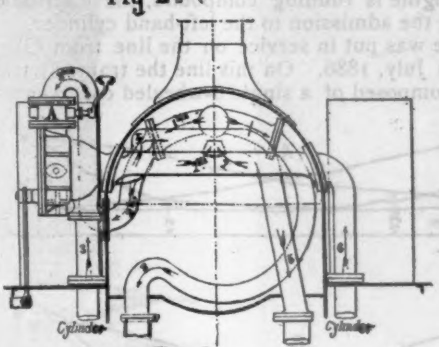


Fig. 4

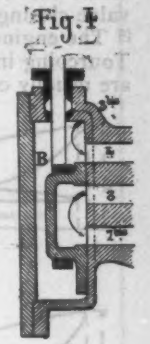


Fig. 3.

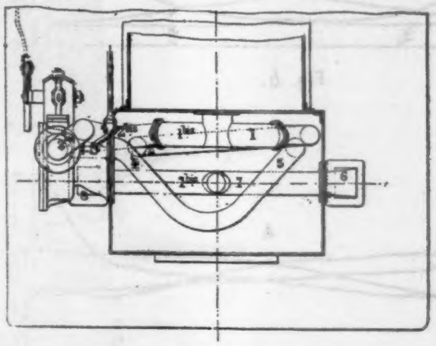
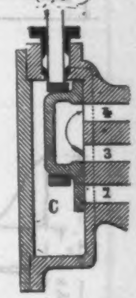


Fig. 5.

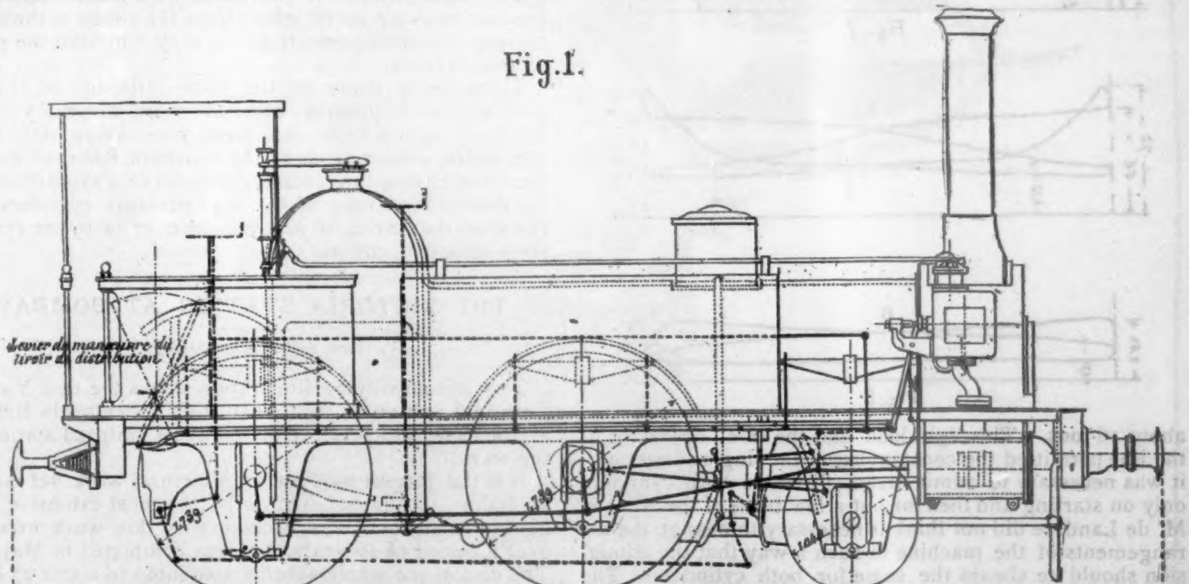


from the boiler to both cylinders or to one cylinder only, at the option of the engineer, the arrangement by which this is effected being shown in figs. 2 and 3.

When it is desired to admit steam from the boiler to both cylinders the valve *A*, fig. 2, is open and the distributing valve is in the position *B*, fig. 4. Steam is then admitted to the right-hand cylinder by the pipe 1 2, and to the left-hand cylinder by the pipe 1′ 2′ 3′, the distributor and the pipe 4 5. The exhaust takes place through the pipe 6 7 for the left-hand cylinder and through the pipe 3, the distributing valve and the pipe 7′ for the right-hand cylinder.

When steam from the boiler is admitted only to the high-pressure cylinder the valve *A* is shut, and the valve in the

Fig. 1.



steam-chest is in the position *C*, fig. 5. Steam is then admitted into the right-hand cylinder by the passage 1 2, and escapes by the passage 3 in the interior of the distributing valve; it then passes into the left-hand cylinder through the pipe 4 5, and from that cylinder is exhausted into the chimney by the pipe 6 7. The valve *A* may remain open when the engine is running compound, the distributing valve closing the admission to the left-hand cylinder.

The engine was put in service on the line from Lille to Tourcoing in July, 1886. On this line the tramway trains are usually composed of a single 8-wheeled car, weighing

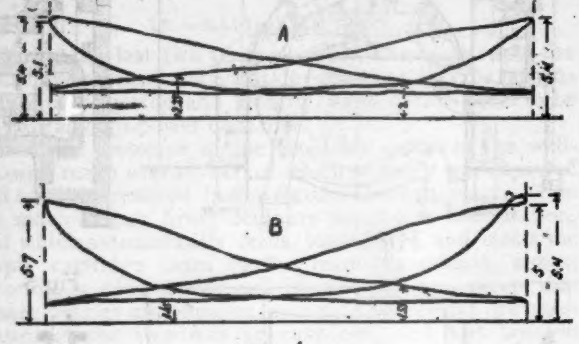


Fig. 6.

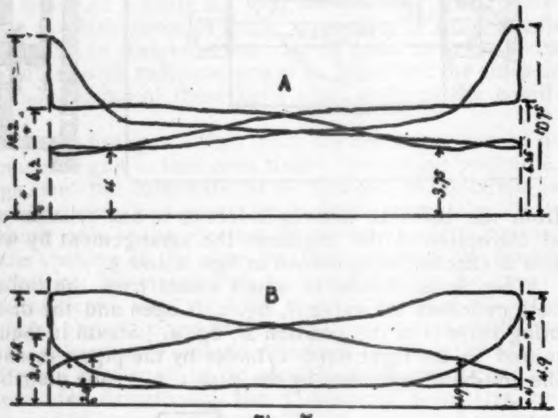


Fig. 7.

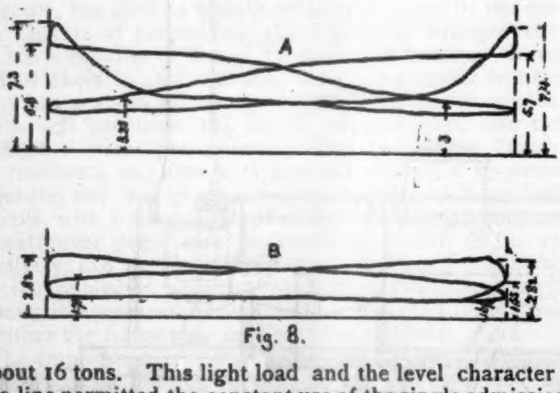


Fig. 8.

about 16 tons. This light load and the level character of the line permitted the constant use of the single admission; it was necessary to admit steam direct to both cylinders only on starting and then for but a few turns of the wheels. M. de Landsee did not think it necessary to change the arrangements of the machine in such a way that the admission should be always the same for both cylinders. The inconvenience of this arrangement was shown in the first diagrams taken from the machine; while running with direct admission to the high-pressure cylinder only and cutting off at from 50 to 60 per cent. of the stroke, the compressions in that cylinder were as high as 125 to 140 lbs., although boiler pressure was only about 72 lbs.; moreover, the work indicated in the two cylinders was different.

Under the advice of M. de Bousquet the distribution of the two cylinders was made independent by adding a special reversing arrangement to the left-hand cylinder, and an invariable rule was adopted of leaving this at its maximum admission, 85 per cent. This rule was established by analogy with the ordinary compound engine; in this case the two cylinders being equal, the admission to the second cylinder should be made during the entire stroke. This new arrangement, while reducing the counterpressure of the first cylinder, made a much better division of the work and decreased, at the same time, the pressure in the admission cylinder.

The accompanying cuts, figs. 6, 7, and 8, show three series of diagrams taken from the cylinders under the three conditions in which the engine can be run. In each case *A* is the diagram from the right-hand cylinder, and *B* that from the left-hand. Fig. 6 shows diagrams taken when the engine was running with steam from the boiler admitted to both cylinders. Fig. 7 shows diagrams taken when the engine was running compound, but with an equal opening for each cylinder. Fig. 8 gives diagrams taken while the engine was running compound, with an admission to the left-hand cylinder for 85 per cent. of the stroke.

These three groups of diagrams show about the same power developed for each revolution of the wheel. An indicator of the Deprez system was mounted at each side of the engine, and this arrangement permitted diagrams to be taken simultaneously from both cylinders. Some tests for coal consumption were made on this engine both for running compound and in the ordinary way, but the trials were too short to enable engineers to give exact figures, which would not be open to criticism. It may be said, however, that the engine, drawing light trains on a level line, and running on the compound principle, burns from 10 to 12 per cent. less fuel than when running in the ordinary manner. This, however, only applied when the distribution of steam to the two cylinders was made independent, as stated above.

Although, from a certain point of view, the results were favorable, the use of this system has not been extended on the Northern Railroad. In the first place it is applicable only to locomotives having cylinders with separate steam-chests, and the number of these on that road is very small. In the second place the advantages would be important on a line of light traffic where fuel was dear and where the work to be done, even if variable, was never very heavy; but for heavy traffic the effort must be always to obtain the greatest possible useful effect from the steam without employing any arrangements which may diminish the power of the machine.

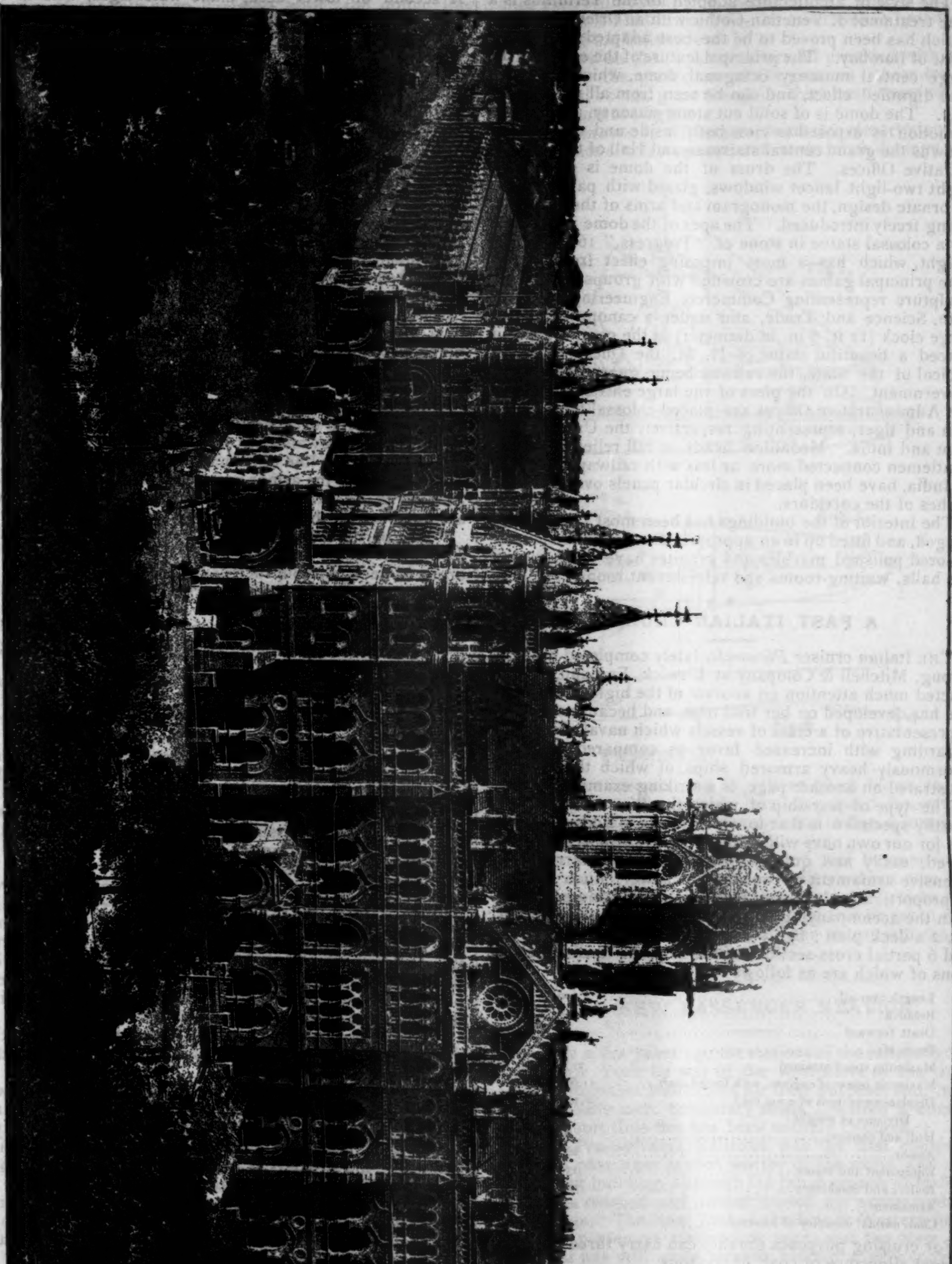
Experiments made on the State railroads of Holland with similar apparatus resulted more favorably. Two different engines were used there, one having both cylinders of the same size, as in the Northern Railroad engine, the other having low-pressure cylinders the same diameter, but double the stroke of the high-pressure cylinders. In this case the saving in fuel was from 17 to 19 per cent. in the compound engine.

THE VICTORIA STATION AT BOMBAY.

(From *Indian Engineering*.)

THE accompanying illustration shows the new Victoria Terminal Station of the Great Indian Peninsula Railway at Bombay, which is one of the finest railroad stations in the world.

It is the largest modern architectural work yet erected in India, and is believed to be the most extensive of its kind in existence. The execution of this work extended over a period of 10 years, and was completed in May last. The cost of the whole scheme amounted to about 27 lakhs of rupees ($964,000). The total length of the façade facing Hornby Row is over 1,500 ft. The author of the design is Mr. F. W. Stevens, late of the Public Works Department, who also supervised the construction of the buildings from the commencement to the end. The site on which the buildings are erected faces that on which the new Municipal Buildings are to be built, also from the designs and under the supervision of Mr. Stevens.



THE NEW VICTORIA STATION, BOMBAY, INDIA.

The style of architecture adopted for the Terminus is a free treatment of Venetian-Gothic with an Oriental feeling, which has been proved to be the best adapted for the climate of Bombay. The principal feature of the edifice is the large central masonry octagonal dome, which has a fine and dignified effect, and can be seen from all parts of the city. The dome is of solid cut stone masonry, and its construction is exposed to view both inside and outside. It crowns the grand central staircase and Hall of the Administrative Offices. The drum of the dome is pierced by eight two-light lancet windows, glazed with painted glass of ornate design, the monogram and arms of the Company being freely introduced. The apex of the dome is crowned by a colossal statue in stone of "Progress," 16 ft. 6 in. in height, which has a most imposing effect from below. The principal gables are crowned with groups of colossal sculpture representing Commerce, Engineering, Agriculture, Science and Trade, and under a canopy below the large clock (12 ft. 6 in. in diameter) in the central gable is placed a beautiful statue of H. M. the Queen-Empress, typical of the State, the railway being guaranteed by the Government. On the piers of the large entrance gates to the Administrative Offices are placed colossal figures of a lion and tiger, representing respectively the United Kingdom and India. Medallion heads in full relief of various gentlemen connected more or less with railway enterprise in India, have been placed in circular panels over the outer arches of the corridors.

The interior of the buildings has been most skillfully arranged, and fitted up in an appropriate and artistic manner. Colored polished marbles and granites have been used in the halls, waiting-rooms and refreshment rooms.

A FAST ITALIAN CRUISER.

THE Italian cruiser *Piemonte*, lately completed by Armstrong, Mitchell & Company at Elswick, England, has attracted much attention on account of the high speed which she has developed on her trial trips, and because she is the representative of a class of vessels which naval officers are regarding with increased favor as compared with the enormously heavy armored ships, of which the *Benbow*, illustrated on another page, is a striking example.

The type of war-ship of which the *Piemonte* is a noteworthy specimen is that to which the new 2,000-ton cruisers for our own navy will belong—lightly armored, of great speed, easily and quickly manœuvred, and carrying an offensive armament of considerable power, much greater, in proportion to their size, than the heavy armored ships.

In the accompanying illustrations fig. 1 is an elevation; fig. 2 a deck plan; fig. 3 a wave-line diagram; figs. 4, 5 and 6 partial cross-sections of the ship, the leading dimensions of which are as follows:

Length over all	300 ft.
Breadth " "	38 "
Draft forward	14 "
Draft aft	16 "
Maximum speed attained	21¼ knots.
Maximum power of engines, with forced draft	11,600 H.P.
Displacement (tons of 2,240 lbs.)	2,500 tons.
Division of weight:	
Hull and fittings	970 "
Armor	280 "
Equipment and stores	130 "
Boilers and machinery	720 "
Armament	200 "
Coal, normal capacity of bunkers	200 "

For cruising purposes the ship can carry three times her normal allowance of coal, or 600 tons.

The machinery and boilers are entirely below the water-line, and are protected by the armored deck, which also covers the magazines, the steam-steering apparatus, and the electric light plant.

This armored deck extends the whole length of the ship, and varies from 1 in. to 3 in. in thickness. All the hatchways, which must be left open in action, are enclosed in bulkheads rising 4 ft. above the construction water-line.

The ship is divided by bulkheads into a number of water-tight compartments. Each engine is in a separate compartment, and the boilers are also placed in a compartment. A second or lower deck, made water-tight, extends the greater part of the length of the ship, and is broken only over the boiler-room. This deck is shown in dotted lines in fig. 1.

The coal-bunkers are placed on either side of the engines and boilers, serving as further protection to those vital parts of the ship. These bunkers are between the upper deck and the armored deck, extending along the side of the ship, and are divided into rooms 10 to 12 ft. long by the cross-bulkheads. Fore and aft of the boiler-rooms and under the armored deck is a space from 2 ft. to 3 ft. high, which can also be used for the storage of coal.

The arrangement of the main bunkers is shown in cross-section in fig. 4; in this the lower part is shown occupied by briquettes of compressed fuel. This fuel is not only of higher heating power than ordinary coal, but also has the advantage that it can be packed down so tightly that water can hardly pass through it should the side be penetrated by a shot, and it also offers greater resistance to a projectile than loose coal. Coal in sacks, or briquettes, can also be packed over the armored deck to a height of 2 ft. This serves as some additional protection when, by the consumption of the coal stored below, the ship is lightened, so that the armored deck rises slightly above the water-line.

With a full allowance of coal on board, the armored deck is 6 in. below the line of normal immersion.

In relation to the armor protection of this ship, the *Mittheilungen aus dem Gebiete des Seewesens*—to which we are indebted for the illustrations—says:

"The partial sections given in figs. 5 and 6 show the side-armor which the *Piemonte* could carry instead of the armored deck, without increasing her displacement.

"Fig. 5 shows the arrangement of the armor under the condition that the weight of the coal-briquettes—100 tons—shall be dispensed with; fig. 6 the arrangement under the assumption that the ship shall carry the normal weight of coal—200 tons.

"In both cases the unbroken deck-plating along the upper side of the armored belt is of equal strength with the horizontal part of the actual armored deck of the *Piemonte*—that is, 1 in. thick. In the most favorable case, in fig. 5, the broadside resistance—counting in the teakwood backing and the side-plating—would be equal to that of a solid armor-plate 10½ in. thick.

"If in this ship the weight of the briquettes were replaced by armor, as assumed in fig. 5, the thickness of the sloping part of the armored deck could be increased to 6 in., and such a deck would be equal in protection to side-plating 14 in. thick. But it must also be considered that the layer of briquettes will oppose a very useful resistance to a projectile with a bursting charge, since such a shot would be held by it and caused to explode, so that the sloping portion of the armored deck, though only 3 in. thick, would be reached only by the fragments of an exploded shell, while the heavy side-plating would receive the full direct blow of the projectile.

"It may also be noted that the cost of the ship with the armored deck is much less than it would be with side-armor of equivalent strength."

Like all modern cruisers, the *Piemonte* has twin screws. Each screw is driven by a triple-expansion engine having a high-pressure cylinder 36 in. diameter, intermediate cylinder 55 in., and two low-pressure cylinders each 60 in. diameter; the stroke is 54 in. Steam is furnished by four cylindrical boilers, with furnaces at each end, and made to carry a working pressure of 155 lbs. Eight fans are provided for use when the boilers are run with forced draft. The engines and boilers were built by Humphreys, Tennant & Company, at Deptford, England.

A distilling apparatus and an auxiliary condenser are provided in each boiler-room for use with salt water when the ship is at sea.

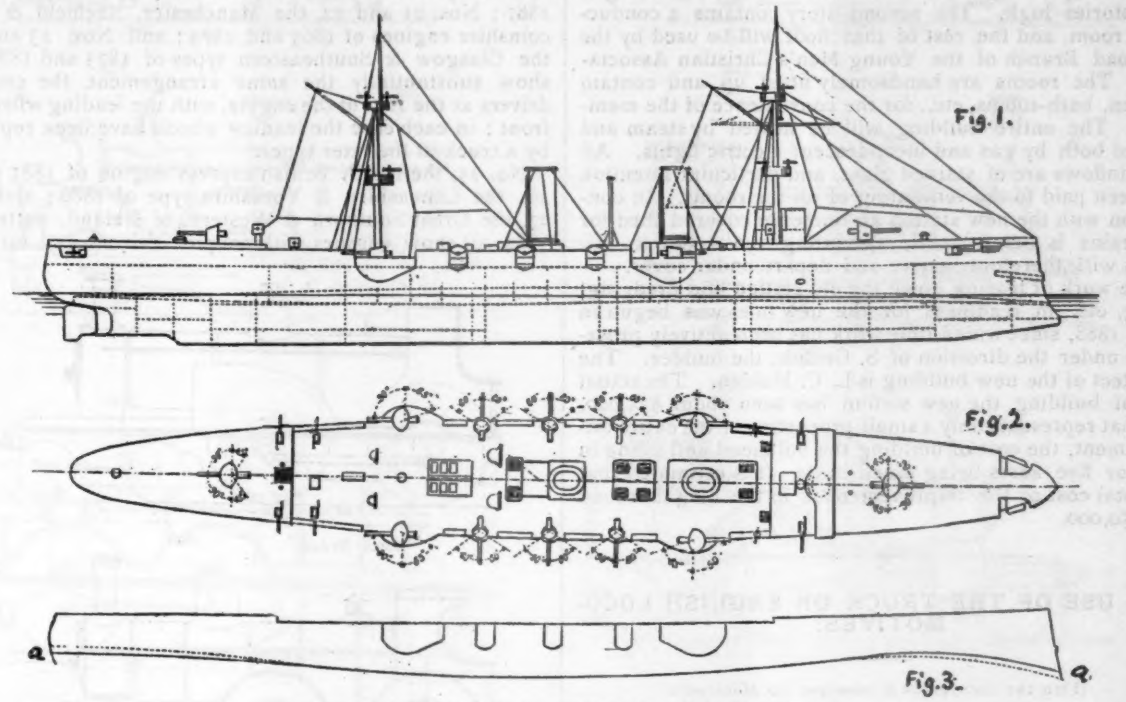
An auxiliary boiler to provide steam for the pumps, electric light, etc., is placed above the armored deck.

On the trial trips the *Piemonte* attained a speed of 19.5 knots with natural draft. With forced draft, but light pressure, a speed of 20.168 knots was attained, and when the full power of the engine is developed and full pressure of forced draft on the boilers, she is expected to reach a speed of 21.5 knots.

In fig. 3 an outline of the ship is shown, and the full line *a a* shows the wave-line, which would be caused by the motion of the ship at 20 knots an hour; the dotted line between the same points is the wave-line at 21 knots.

During the trial trips the vibration of the ship at high speed was taken with a seismometer. It was very small, the variations due to her motion not exceeding 0.12 in. in either the vertical or horizontal direction.

As mentioned above, while the normal coal-supply is 200 tons, the *Piemonte* can stow on occasion 600 tons; with this provision she can run 1,950 knots at full speed with

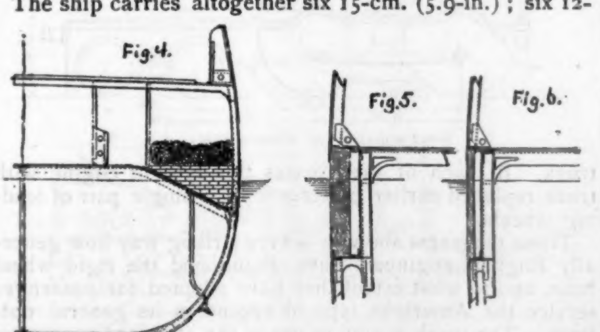


THE FAST ITALIAN CRUISER "PIEMONTE."

natural draft. Making from 10 to 12 knots an hour, 600 tons of coal will carry her about seven times that distance, making her cruising range at low speed about 13,500 knots, or from 50 to 55 days.

The *Piemonte* is not only a typical ship in her construction and machinery, but she has also a claim to notice from the fact that she is the first cruiser of importance armed entirely with rapid-fire guns, thus carrying out the theory that many shots from comparatively light guns may be more effective than few from very heavy guns.

The ship carries altogether six 15-cm. (5.9-in.); six 12-



cm. (4.7-in.); ten 57-mm. (2.24-in.), and six 37-mm. (1.46-in.) rapid-fire guns; four 10-mm. (0.39-in.) Maxim guns and three torpedo-tubes. The arrangement of these guns, as shown on the deck plan, fig. 2, is as follows: Of the 15-cm. guns, two are mounted in pivot, forward and aft, and four in broadside on the upper deck; the six 12-cm. guns are all in broadside. Of the ten 57-mm. guns six are in broadside on the upper deck; the other four are on the lower deck, two forward and two aft. Two of the 37-mm. guns are on deck, in broadside. The two masts of the ship each carry two platforms, or fighting-tops; the two lower ones are each armed with two 37-mm. guns, the two upper ones each with two 10-mm. Maxim guns. One of the torpedo-tubes is fixed in the bow, the other two in broadside, forward of the boiler-room.

The guns on the upper deck are all provided with steel shields for the protection of the gunners; those for the 15-cm. and 12-cm. guns are $4\frac{1}{2}$ in. thick, and those for the smaller guns are lighter.

The *Piemonte*, it will be seen from this description, has the qualities of a fast cruiser, able to do much damage to an enemy's commerce, and to deliver quick blows at unexpected points; she is also, from her speed, heavy armament and quickness in manœuver and in fire, a formidable fighting machine.

The same qualities, it is expected, will be combined in the new 2,000-ton and 3,000-ton cruisers of our own Navy, contracts for which will be let this month. It is to be hoped that in their construction advantage will be taken of the lessons which the *Piemonte* and her sisters will teach by their behavior in service at sea.

A NEW PASSENGER STATION.

ONLY a few years ago the stations of the railroads reaching New York by way of the west shore of the Hudson were altogether insufficient for their purpose, and, indeed, were mostly mere temporary sheds. Within a comparatively short time this has been entirely changed.

The Pennsylvania Railroad was the first company to build a passenger station worthy of the name, and has an excellent building, although the rapid growth of traffic has already reached and almost passed the accommodations it affords. The New York, Lake Erie & Western finished a new passenger station last year, and the New Jersey Central has still more recently erected a very convenient and handsome structure at its Communipaw terminus.

The latest addition to this group of stations is that of the Delaware, Lackawanna & Western at Hoboken, which was opened to the public in July.

The new station is a handsome structure of white pine, finished inside with antique oak. It is 121 × 170 ft. in size, the main waiting-room being 45 ft. clear in height in the center, and measuring 121 × 85 ft. in area. The building runs north and south, with a tower on the northwest or front corner. The eastern half of the station

stands over the river, a bulkhead running clear through it from north to south. The western half is on made ground, as well as a great part of the yard which the trains start from. The main waiting-room contains the ticket-offices, telegraph-office, information-bureau, news-stand, restaurant, etc. There are large separate waiting and toilet-rooms for men and women, a smoking-room, and all the modern conveniences. The waiting-room for passengers arriving on the trains and going to New York is large, well lighted and ventilated. It is 45 × 120 ft. in area and 45 ft. high. The western half of the building is two stories high. The second story contains a conductors' room, and the rest of that floor will be used by the Railroad Branch of the Young Men's Christian Association. The rooms are handsomely fitted up, and contain kitchen, bath-rooms, etc., for the convenience of the members. The entire building will be heated by steam and lighted both by gas and incandescent electric lights. All the windows are of stained glass, and particular attention has been paid to the ventilating of all the rooms. In connection with the new station an immense covered shed for the trains is being built, measuring 190 × 500 ft All trains will, therefore, arrive and depart under cover.

The work of tearing down the old station and dredging, filling, etc., in readiness for the new one, was begun in June, 1888, since which time work has been actively prosecuted under the direction of S. Griffith, the builder. The architect of the new building is L. C. Holden. The actual cost of building the new station has been about $25,000, but that represents only a small proportion of the entire improvement, the cost of building the bulkhead and filling in four or five acres being much more It is estimated that the total cost of the improvement is in the neighborhood of $250,000.

THE USE OF THE TRUCK ON ENGLISH LOCOMOTIVES.

(From the *Portefeuille Economique des Machines.*)

It has seemed to us, in considering the English locomotive, that it would be very interesting to show how much the use of the truck has increased in England, both for express locomotives and for smaller engines, especially tank engines used in local traffic. With this object we show in the accompanying illustrations a number of diagrams on a small scale representing in outline the types of locomotives recently adopted on most of the principal English railroads; at the same time comparing them with the types formerly in service. In each of these diagrams the date placed above the engine shows the year of the adoption of that special type.

Nos. 1–4 show the engines of the Midland Railway; No. 1 being the type of 1860, with its single drivers, leading and trailing wheels; No. 2 the type of 1875 with the coupled drivers and leading wheel. In 1878, No. 3, the leading wheel was replaced by a truck, the coupled drivers being retained, but in the latest type—that of 1887, No. 4—a single pair of very large drivers is substituted for the coupled wheels, a pair of trailing wheels being placed behind the fire-box and the truck in front being still retained.

On the Great Eastern—Nos. 5–8—the development proceeded, as will be seen, on very similar lines, the only difference being that on this road the coupled drivers with truck succeeded the single drivers and trailing wheels, which appear in the type of 1880.

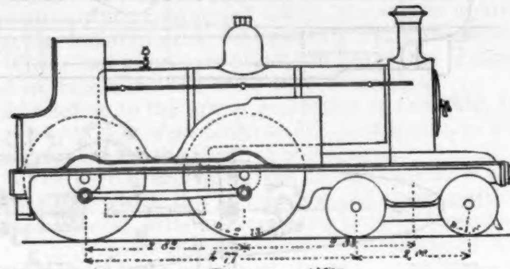
On the Great Northern the type of 1858 and that of 1870 differ only in the substitution of the truck for the leading wheels, as shown in Nos. 9 and 10. On the Caledonian—Nos. 11 and 12—the types of 1862 and 1886 are substantially the same as on the Great Northern, here also the truck being substituted for the single pair of leading wheels.

On the London & Southwestern two classes of engines are shown, the fast passenger engine of 1860, No. 13, being succeeded by the type of 1883, No. 16, the change, as in all the previous instances, being made by the substitution of the truck for the leading wheels. Nos. 14 and 15 show the local passenger engine of this road; here again the truck at the forward end has supplanted the single pair of wheels.

The Southeastern types show an engine of the Forney pattern with tank and coal-box carried on an extension of the frame, the coupled driving-wheels being placed under the boiler, with the truck under the tank. This is the type of 1878, No. 18, which succeeded No. 17, the type of 1860, in which there was the same arrangement of relative position of boiler and tank, but with a single pair of wheels under the tank in place of the truck.

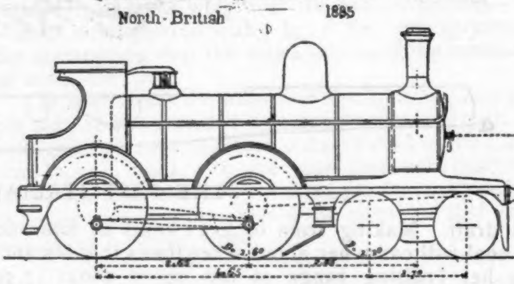
Nos. 19 and 20, the Northeastern types of 1874 and 1887; Nos. 21 and 22, the Manchester, Sheffield & Lincolnshire engines of 1865 and 1879; and Nos. 23 and 24, the Glasgow & Southeastern types of 1873 and 1883, all show substantially the same arrangement, the coupled drivers at the rear of the engine, with the leading wheels in front; in each case the leading wheels have been replaced by a truck in the later types.

No. 25, the North British express engine of 1885; No. 26, the Lancashire & Yorkshire type of 1886; and No. 27, the Great Southern & Western, of Ireland, pattern of 1884, all show engines with coupled drivers and forward truck. In each of these cases this type of engine with truck replaced earlier patterns with a single pair of leading wheels.



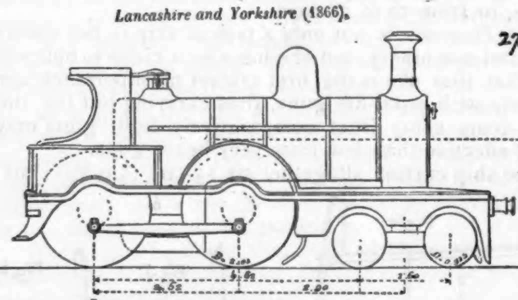
North-British 1885

26.



Lancashire and Yorkshire (1866).

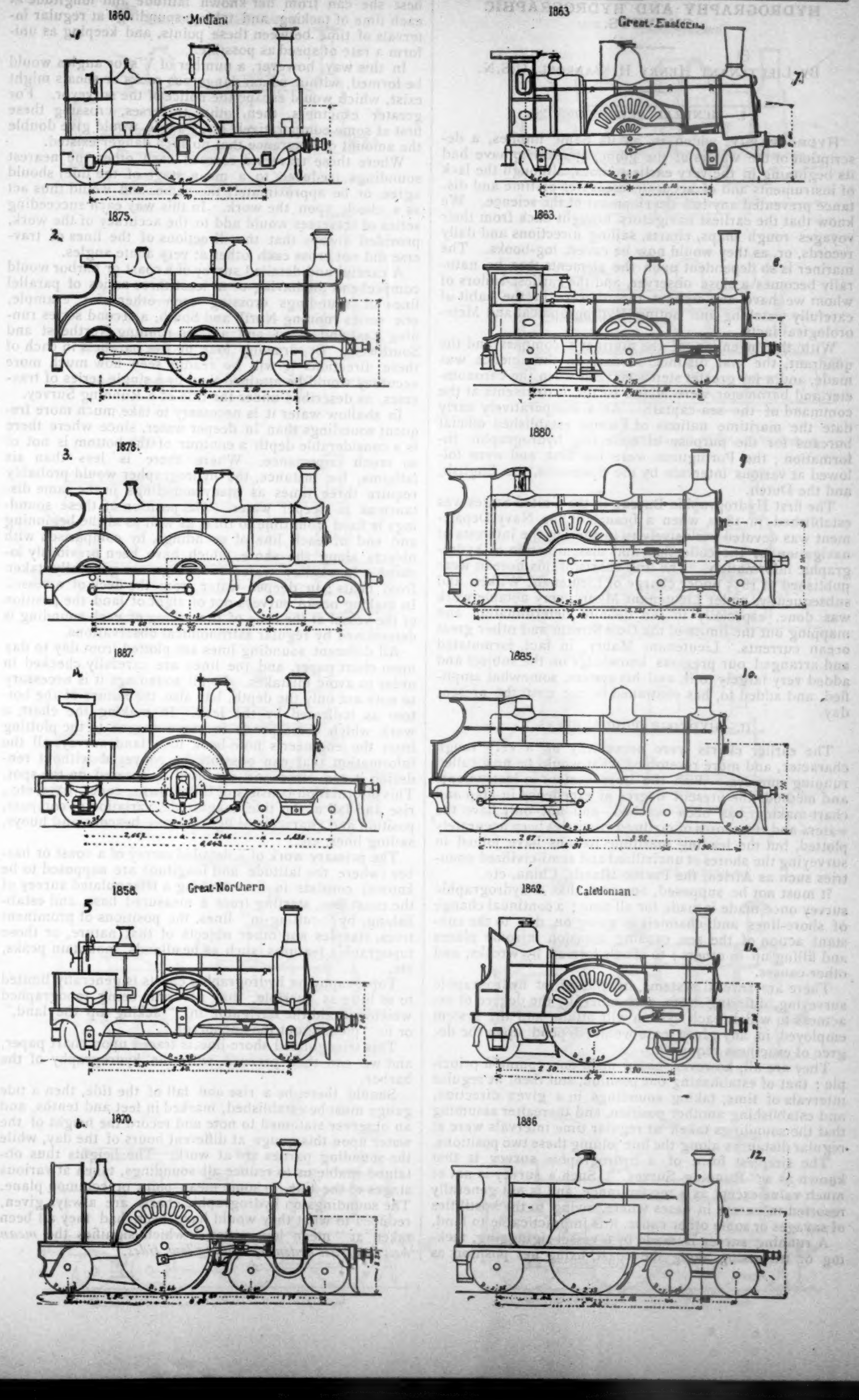
27.



Great Southern and Western (1884).

These diagrams show in a very strikng way how generally English engineers have abandoned the rigid wheel base, and to what extent they have adopted for passenger service the American type of engine in its general outlines. The truck is now in use in the standard passenger engines of all except two or three of the principal English roads. It has been adopted in that country to a very much greater extent than on the railroads of France and Germany, where as yet the American type is very little known.

It must be remarked that this adoption of the truck in England has not resulted from any expectation of increase of power of the engine, which, of course, could not be secured in this way, nor has it been done to save the road-bed, for, as is well known, the English lines are of extreme solidity. The object has evidently been to increase the stability of the engine, especially at the very high speeds at which trains are now run in that country.


1860. Midland
1
1875.
2.
1878.
3.
1887.
4.
1858. Great-Northern
5
1870.
6.
1863 Great-Eastern
7.
1863.
8.
1880.
1885.
1862. Caledonian
11.
1886
12.

HYDROGRAPHY AND HYDROGRAPHIC SURVEYS.

By Lieutenant Henry H. Barroll, U.S.N.

I.—GENERAL DEFINITIONS.

Hydrography, which is, as its name implies, a description of the waters of the globe, appears to have had its beginning in the very earliest times, although the lack of instruments and of accurate measures of time and distance prevented any full development of the science. We know that the earliest navigators brought back from their voyages rough maps, charts, sailing directions and daily records, or, as they would now be called, log-books. The mariner is so dependent upon the elements that he naturally becomes a close observer, and the earliest sailors of whom we have any distinct record were in the habit of carefully watching and noting Hydrographical and Meteorological facts.

With the invention of the mariner's compass and the quadrant, the first distinct advance in the science was made, and a far greater step was taken when the chronometer and barometer were added to the instruments at the command of the sea-captain. At a comparatively early date the maritime nations of Europe established official bureaus for the purpose of collecting hydrographic information; the Portuguese were the first, and were followed at various intervals by the Spaniards, the English, and the Dutch.

The first Hydrographic Bureau in the United States was established in 1830, when a branch of the Navy Department was devoted exclusively to furthering the interests of navigation by the collection and dissemination of hydrographic information. The first charts of this bureau were published in 1835 under charge of Lieutenant Wilkes, and subsequently, under Lieutenant Maury, very notable work was done, especially in the definite determination and mapping out the limits of the Gulf Stream and other great ocean currents. Lieutenant Maury, in fact, formulated and arranged our previous knowledge on the subject and added very largely to it, and his system, somewhat amplified, and added to, has continued in use until the present day.

II.—HYDROGRAPHIC SURVEYS.

The earlier charts were necessarily of a very rough character, and more resembled what would be now called running surveys. With the improvement in instruments and methods the present degree of excellence in map and chart-making has been reached, and not only have the waters and the shores of civilized countries been accurately plotted, but the leading maritime nations have joined in surveying the shores of uncivilized and semi-civilized countries such as Africa, the Pacific Islands, China, etc.

It must not be supposed, however, that a hydrographic survey once made is made for all time; a continual change of shore-lines and channels is going on, due to the constant action of the sea, causing abrasion in some places and filling up in others; to shoals formed by wrecks, and other causes.

There are several systems, or classes, of hydrographic surveying, differing from each other by the degree of exactness to which each system will attain, and the system employed in any given case would depend upon the degree of exactness required.

They are all, however, based upon one common principle: that of establishing one position, and then, at regular intervals of time, taking soundings in a given direction, and establishing another position, and thereafter assuming that the soundings taken at regular time intervals were at regular distances along the line joining these two positions.

The simplest form of a hydrographic survey is that known as a "Running Survey." Such a survey is not of much value except as a recognizance, and is not generally resorted to except in cases where, owing to the hostilities of savages or some other cause, it is impracticable to land.

A running survey is made by a vessel zigzagging, tacking or traversing along the coast, fixing her position as best she can from her known latitude and longitude at each time of tacking, and taking soundings at regular intervals of time between these points, and keeping as uniform a rate of speed as possible.

In this way, however, a number of V's or angles would be formed, within which dangerous rocks or shoals might exist, which would escape the notice of the surveyor. For greater exactness, then, other traverses, crossing these first at some comparatively large angle, would give double the amount of assurance that no such danger existed.

Where these traverses crossed each other the nearest soundings (reduced to a mean stage of the tide) should agree, or be approximately the same, and would thus act as a check upon the work. In this way each succeeding series of traverses would add to the accuracy of the work, provided always that the directions of the lines of traverse did not cross each other at very acute angles.

A careful and detailed survey of a coast or harbor would comprehend the having of at least three series of parallel lines of soundings crossing each other—for example, one series running North and South, a second series running East and West, and a third running Northeast and Southwest. By drawing four or five parallels in each of these directions it will be readily seen how much more accuracy would be attained than by a single series of traverses, as described under the title of a Running Survey.

In shallow water it is necessary to take much more frequent soundings than in deeper water, since where there is a considerable depth a contour of the bottom is not of so much importance. Where there is less than six fathoms, for instance, the hydrographer would probably require three times as many soundings in the same distance as in deeper water. The position of these soundings is fixed from time to time, as well as at the beginning and end of each line of soundings, by comparison with objects along the shore, which have been previously located. In shallow water soundings are generally taken from boats; in deeper water from the deck of a vessel. In making ocean surveys out of sight of land the position of the vessel at the time of the taking of each sounding is determined by regular astronomical observations.

All different sounding lines are plotted from day to day upon chart paper, and the lines are carefully checked in order to avoid mistakes. In all soundings it is necessary to note not only the depth, but also the nature of the bottom as indicated by the lead. In making the chart, a work which corresponds in some degree to the plotting from the engineer's note-book in a land survey, all the information that can possibly be conveyed without rendering it too close and confused is entered on the spot. This information consists of hills, towns, capes, bays, etc., rise and fall of the tide, magnitude, variation of compass, position and character of light-houses, beacons and buoys, sailing lines, etc.

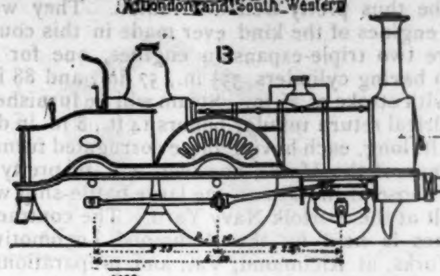
The primary work of a detailed survey of a coast or harbor (where the latitude and longitude are supposed to be known) consists in first making a triangulated survey of the coast line, starting from a measured base, and establishing, by "cutting-in" lines, the positions of prominent trees, steeples and other objects of that nature, or those topographic features, such as headlands, mountain peaks, etc.

Topography on hydrographic charts is generally limited to as little as possible, that part only being topographed which will aid the navigator in "picking up the land," or in "picking out the anchorage."

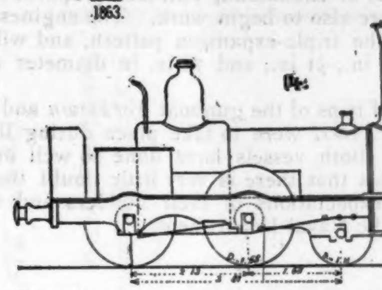
This triangulated shore-line is traced upon chart paper, and we can then proceed with the hydrography of the harbor.

Should there be a rise and fall of the tide, then a tide gauge must be established, marked in feet and tenths, and an observer stationed to note and record the height of the water upon this gauge at different hours of the day, while the sounding parties are at work. The heights thus obtained enable us to reduce all soundings, taken at various stages of the tide, to some mean point or common plane. The soundings on hydrographic charts are always given, reduced to what they would have been had they all been taken at "mean low water," which signifies the *mean height of all ordinary spring low tides.*

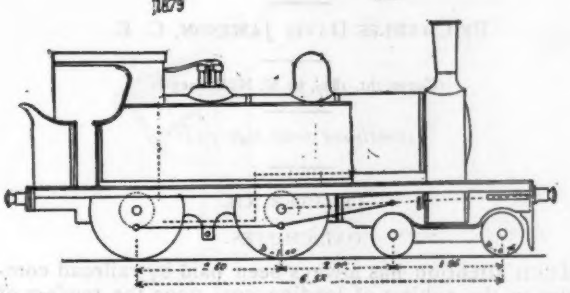
1860. London and South-Western.



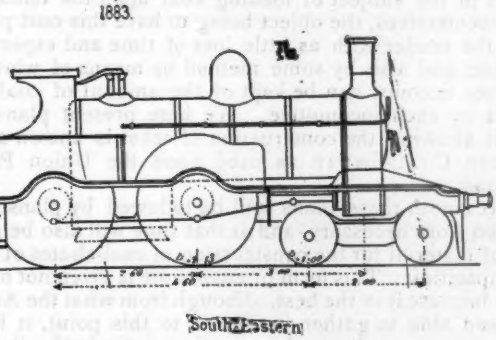
1863.



1879.

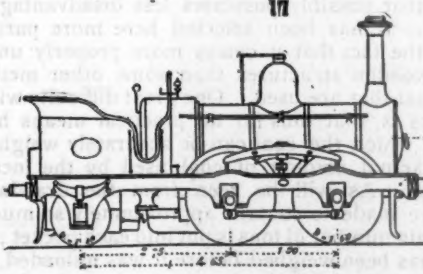


1883.

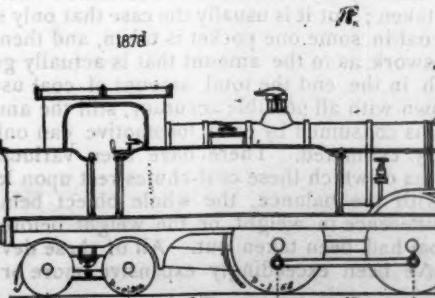


South-Eastern.

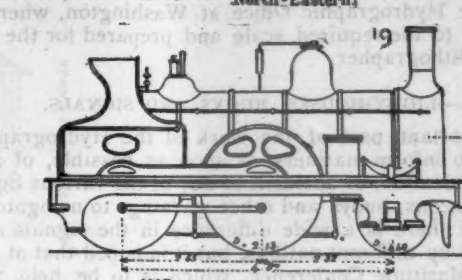
1860.



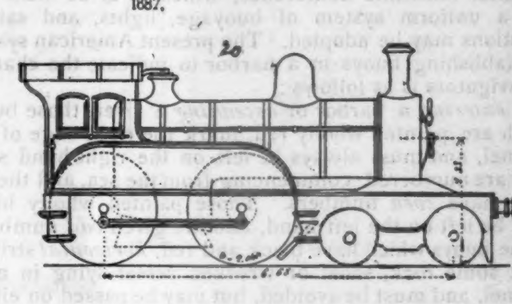
1878.



1874. North-Eastern.

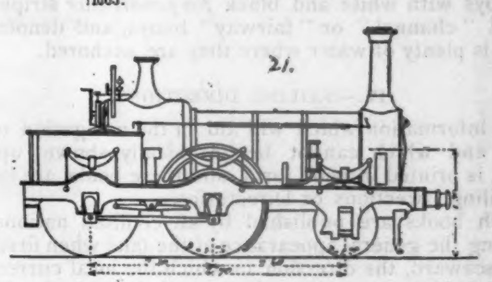


1887.

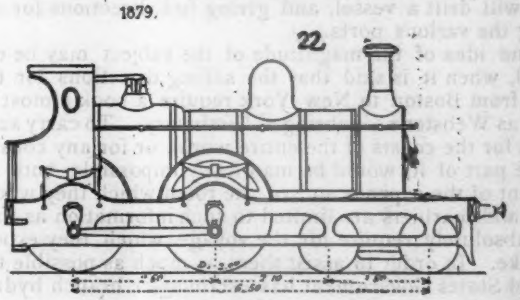


Manchester, Sheffield and Lincolnshire.

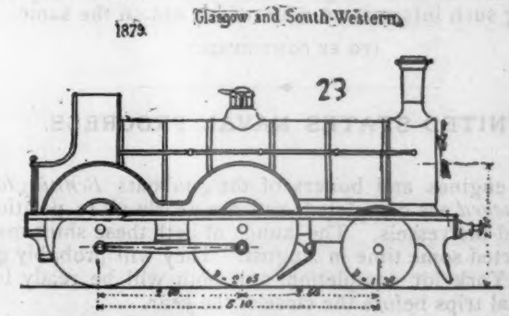
1865.



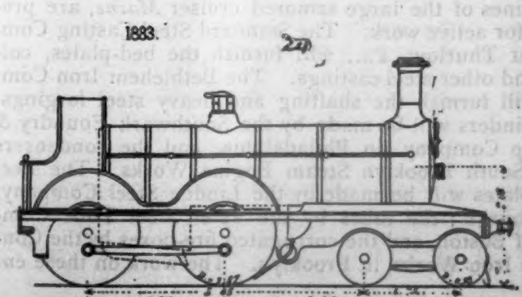
1879.



1879. Glasgow and South-Western.



1883.



When the chart as plotted on board is complete, it is sent to the Hydrographic Office at Washington, where it is reduced to the required scale and prepared for the engraver or lithographer.

III.—LIGHT-HOUSES, BUOYS AND SIGNALS.

An important part of the work of the Hydrographic Office is to inform mariners, as soon as possible, of any change in location, or accident to any of the various light-houses, beacons, buoys and other warnings to navigators. At present there is a wide difference in the signals and lights used by different nations, but it is hoped that at the National Maritime Conference, which is to be held this fall, a uniform system of buoyage, lights, and sailing directions may be adopted. The present American system of establishing buoys in a harbor to indicate the channel to navigators is as follows:

In *entering* a harbor or *ascending* a river, those buoys which are painted wholly red, mark the right edge of the channel, and must always be left on the right-hand side. They are numbered, commencing from the sea, and the red buoys have *even* numbers. Those painted wholly black must be left on the left hand, and are given *odd* numbers.

The buoys which have black and red, *horizontal* stripes, mark some rock, shoal or wrecked vessel lying in mid-channel, and must be avoided, but may be passed on either side.

Buoys with white and black *perpendicular* stripes are called "channel" or "fairway" buoys, and denote that there is plenty of water where they are anchored.

IV.—SAILING DIRECTIONS.

All information which will aid in the navigation of the seas, and which cannot be graphically shown upon a chart, is printed in book form, and these books are known as Sailing Directions or Directories.

Such books are published by all civilized nations, describing the general appearance of the land when first seen from seaward, the direction in which the local currents or tides will drift a vessel, and giving full directions for entering the various ports.

Some idea of the magnitude of the subject may be obtained, when it is said that the sailing directions for the coast from Boston to New York require a book almost as large as Webster's Unabridged Dictionary. To carry such books for the coasts of the entire world, or for any considerable part of it, would be manifestly impossible, both on account of the expense and of the room which they would take, and mariners are limited to such information as they may absolutely require for the voyage which they expect to make. In order to assist them as much as possible the United States Government has established branch hydrographic offices in all large seaboard cities, where any one desiring such information may readily obtain the same.

(TO BE CONTINUED.)

UNITED STATES NAVAL PROGRESS.

THE engines and boilers of the gunboats *Bennington* and *Concord* are completed, and are nearly all in position on board the vessels. The launch of both these ships may be expected some time in August. They will probably go to New York for completion, and both will be ready for their trial trips before the close of the year.

The Quintard Iron Works of New York, Contractors for the engines of the large armored cruiser *Maine*, are preparing for active work. The Standard Steel Casting Company, at Thurlow, Pa., will furnish the bed-plates, columns and other steel castings. The Bethlehem Iron Company will furnish the shafting and heavy steel forgings. The cylinders will be made by the Southwark Foundry & Machine Company, in Philadelphia, and the condensers by the South Brooklyn Steam Engine Works. The steel boiler plates will be made by the Linden Steel Company, in Pittsburgh; the tubes by the Tyler Steel Tube Company, of Boston, and the corrugated fire-boxes by the Continental Iron Works, in Brooklyn. The work on these engines will be thus pretty well distributed. They will be the largest engines of the kind ever made in this country.

There are two triple-expansion engines, one for each screw, each having cylinders 35½ in., 57 in., and 88 in. in diameter, with stroke of 36 in. Steam will be furnished by eight cylindrical return tubular boilers 14 ft., 8 in. in diameter and 10 ft. long, each having three corrugated furnaces.

The engines of the *Maine*, however, will be pretty well matched by those of the *Texas*, the large battle-ship which is to be built at the Norfolk Navy Yard. The contract for these engines is held by the Richmond Locomotive & Machine Works, at Richmond, Va., and preparations are being made there also to begin work. The engines of the *Texas* are of the triple-expansion pattern, and will have cylinders of 36 in., 51 in., and 78 in. in diameter and 39 in. stroke.

The final trial trips of the gunboat *Yorktown* and of the small gunboat *Petrel* were to take place during the last week of July. Both vessels have done so well on their preliminary trials that there is very little doubt that they will fulfil the expectations of their builders and the requirements of the Naval Department.

THE USE OF WOOD IN RAILROAD STRUCTURES.

BY CHARLES DAVIS JAMESON, C. E.

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(*Continued from page* 311.)

CHAPTER XII.

COAL-CHUTES.

MUCH attention has always been paid by railroad companies to the subject of loading coal upon the tenders of their locomotives, the object being to have this coal placed upon the tender with as little loss of time and expense as possible, and also by some method by means of which an accurate account can be kept of the amount of coal consumed by each locomotive. We here present plans and details showing the construction of what is known as the CLIFTON COAL-CHUTE as used upon the Union Pacific Railroad.

Next month these plans will be followed by plans of all the iron work necessary, and at that time will also be given bills of material for the construction of coal-chutes of varying capacities. This form of coal-chute is given not necessarily because it is the best, although from what the Author has been able to gather in regard to this point, it is the one most universally used upon all our standard railroads, and one that possibly possesses less disadvantages than any other. It has been selected here more particularly owing to the fact that it comes more properly under the head of wooden structures than some other methods of loading coal that are used. One great difficulty with these coal-chutes is, that thus far no practical means has been found by which the coal can be accurately weighed, and thus the actual amount of coal used by the locomotive ascertained. As will be seen from the drawings, the pockets are made to contain approximately so much coal, and a certain number of tons is put into each pocket; then as this coal has been weighed before it was unloaded, the actual amount taken by the locomotive is ascertained when full pockets are taken; but it is usually the case that only some part of the coal in some one pocket is taken, and then it is merely guesswork as to the amount that is actually gone; and although in the end the total amount of coal used is actually known with all possible accuracy, still the amount of coal that is consumed by each locomotive can only be approximately estimated. There have been various devices by means of which these coal-chutes rest upon levers connected with the balance, the whole object being to record the difference in weight, or the weight before and after any coal had been taken out. All of these devices, however, have been exceedingly expensive, more or less

PLATE No. 40.

UNION PACIFIC RAILWAY.

STANDARD COAL CHUTE

CLIFTON PATENT

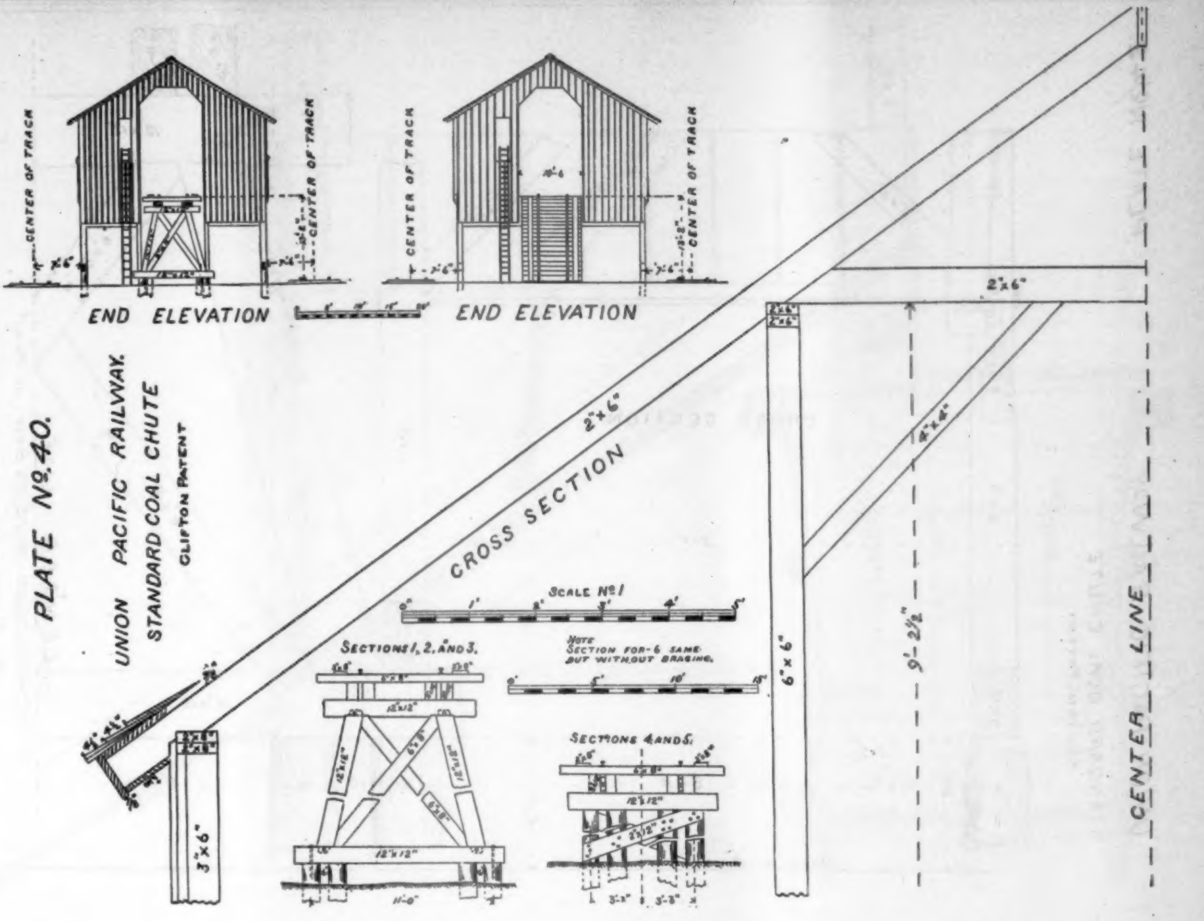
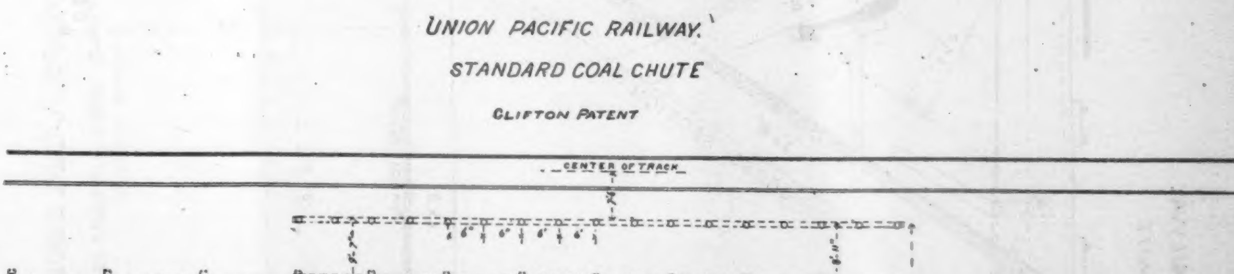


PLATE No. 39



SIDE ELEVATION

UNION PACIFIC RAILWAY.

STANDARD COAL CHUTE

CLIFTON PATENT

GROUND PLAN

PLATE No 42.

UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT

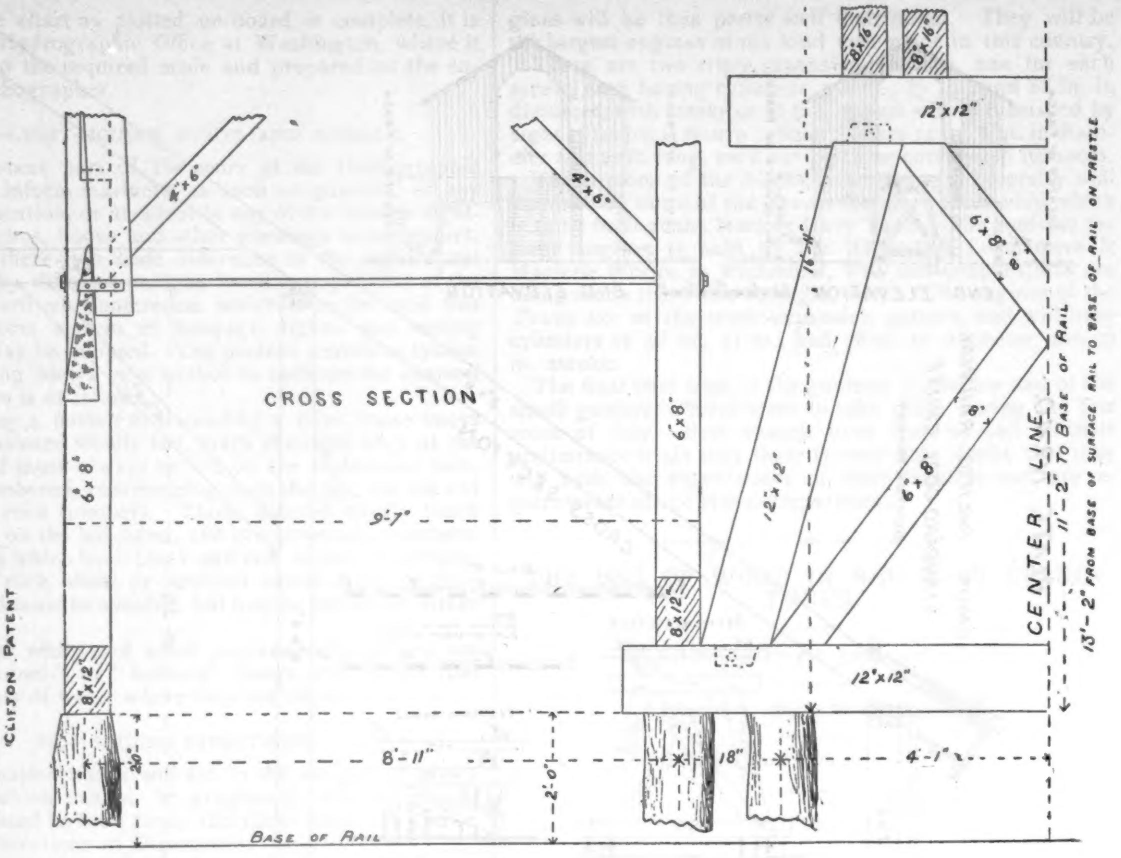
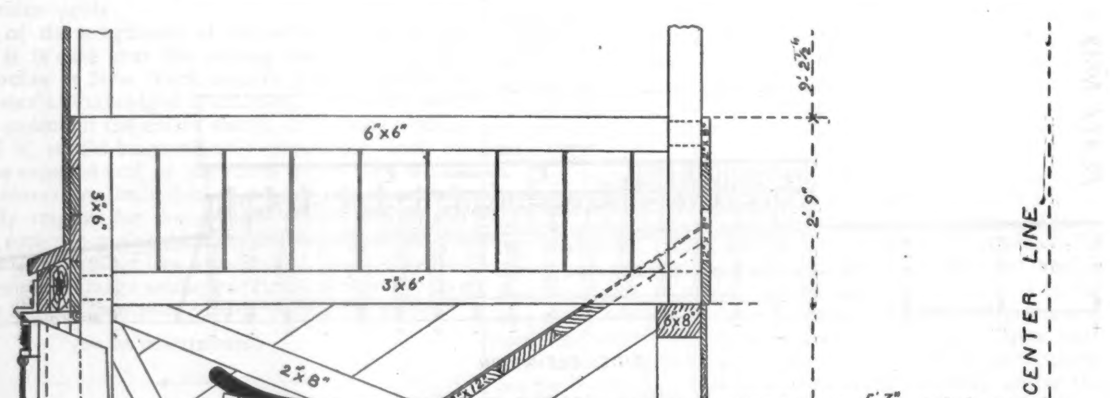


PLATE No 41.

UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT



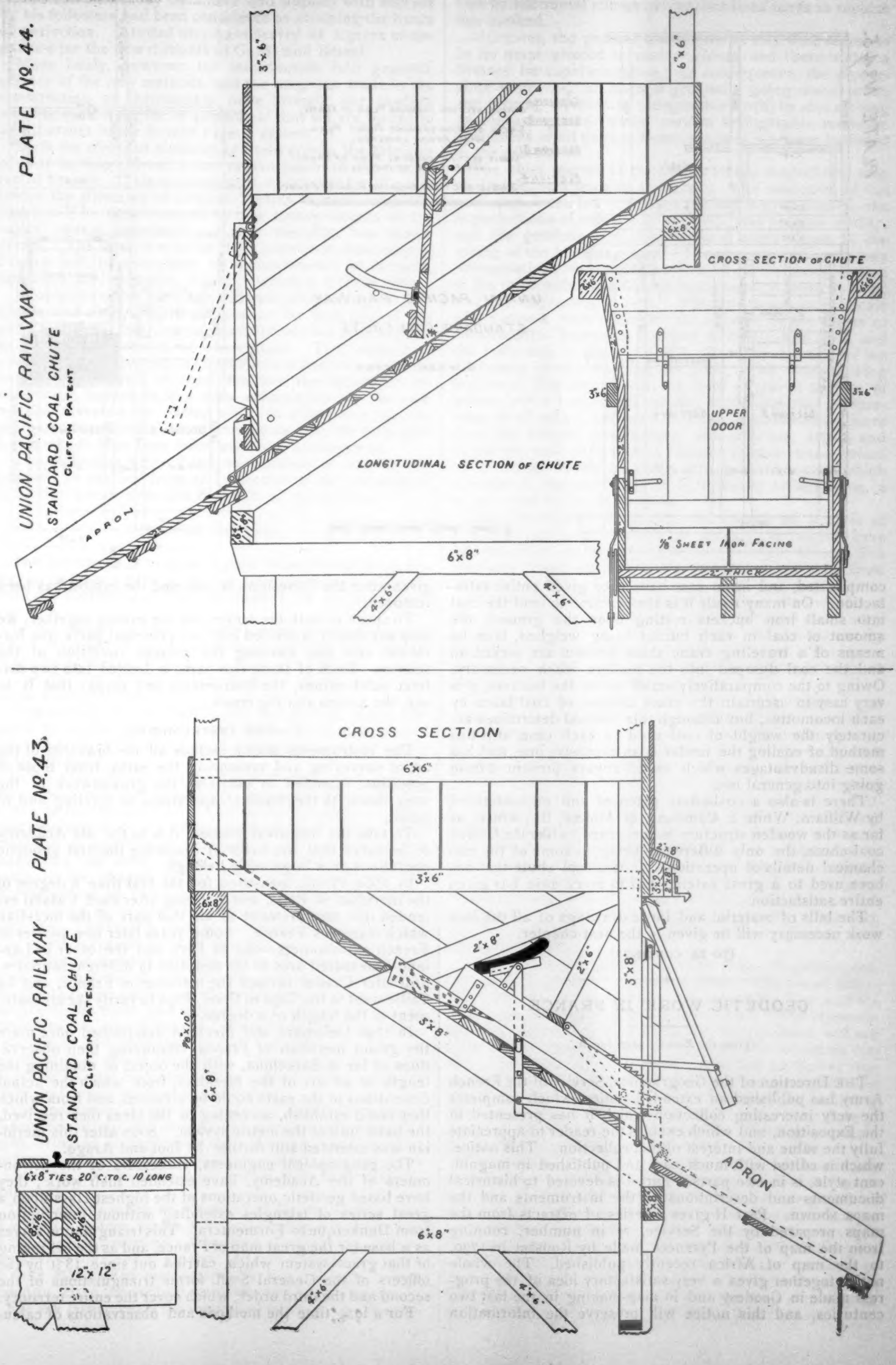
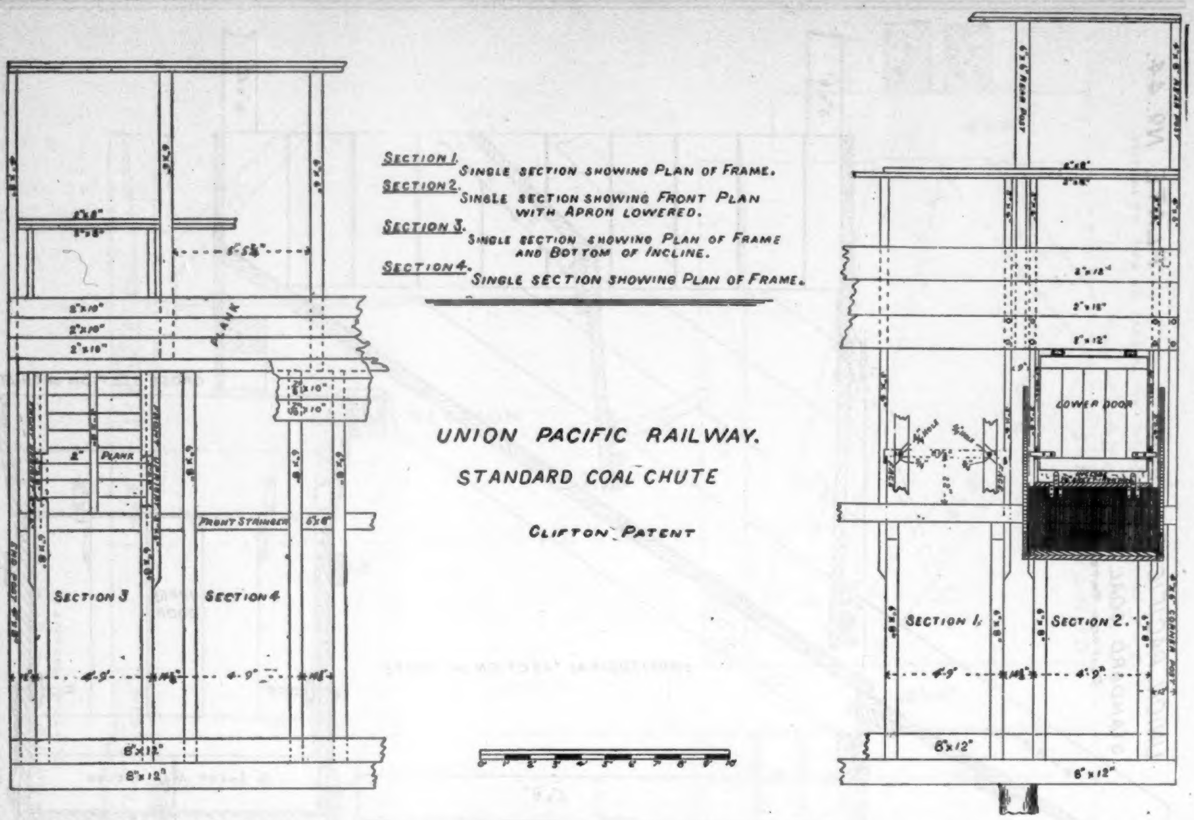


PLATE No. 44.
UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT
LONGITUDINAL SECTION OF CHUTE
CROSS SECTION OF CHUTE
UPPER DOOR
1/8" SHEET IRON FACING
APRON
6"x8"
3"x6"
6"x6"
PLATE No. 43.
UNION PACIFIC RAILWAY
STANDARD COAL CHUTE
CLIFTON PATENT
CROSS SECTION
6"x8" TIES 20" C. TO C. 10' LONG
12"x12"
2"x8"
3"x8"
APRON

PLATE No. 45.



complicated, and in no case have they given entire satisfaction. On many roads it is the practice to load the coal into small iron buckets resting upon the ground, the amount of coal in each bucket being weighed, then by means of a traveling crane these buckets are picked up and the coal dumped into the tenders when necessary. Owing to the comparatively small size of the buckets, it is very easy to ascertain the exact amount of coal taken by each locomotive, but although this method determines accurately the weight of coal used in each case, still this method of coaling the tender is an expensive one, and has some disadvantages which would always prevent it from going into general use.

There is also a coal-chute patented and manufactured by William, White & Company, of Moline, Ill., which, as far as the wooden structure is concerned, is like the Clifton coal-chute, the only difference being in some of the mechanical details of operation. It is a coal chute that has been used to a great extent, and in every case has given entire satisfaction.

The bills of material and large drawings of all the iron work necessary will be given in the next chapter.

(TO BE CONTINUED.)

GEODETIC WORK IN FRANCE.

(From the *Revue Scientifique*.)

THE Direction of the Geographical Service of the French Army has published an extended notice, which completes the very interesting collection which it has presented in the Exposition, and which enables the reader to appreciate fully the value and interest of that collection. This notice, which is edited with much care and published in magnificent style, is in two parts. Part I is devoted to historical documents and descriptions of the instruments and the maps shown. Part II gives a series of extracts from the maps prepared by the Service, 27 in number, running from the map of the Pyrenees made by Roussel in 1730, to the map of Africa recently published. The whole notice together gives a very satisfactory idea of the progress made in Geodesy and in map-making in the last two centuries, and this notice will preserve the information given after the Exposition is over and the exhibit has been removed.

To speak of both the notice and the exhibit together, we may say that it is divided into two principal parts, one historical and one showing the present condition of the science. Each of these two parts is divided into two distinct subdivisions, the instruments and maps—that is to say, the means and the result.

I.—THE INSTRUMENTS.

The instruments shown include all the branches of the art of surveying and measuring the earth, from those of precision, intended to establish the groundwork of the map, down to the smallest operations of leveling and of detail.

To take the historical portion, it is to the old Academy of Sciences that the honor of executing the first geodetic operations on a large scale belongs.

In 1669 Picard measured for the first time a degree of the meridian of Paris, and not long afterward Cassini extended this measurement to all that part of the meridian which traverses France. Some years later two parties of French astronomers—one in Peru and the other in Lapland—measured arcs of the meridian in different latitudes. Still later Cassini revised the meridian of France, and La Caille went to the Cape of Good Hope to verify the measurement of the length of a degree.

In 1790 Delambre and Mechain determined once more the grand meridian of France, continuing their observations as far as Barcelona, with the object of obtaining the length of an arc of the meridian, from which the actual dimensions of the earth could be obtained, and from which they could establish, according to the ideas then received, the basic unit of the metric system. Soon after this meridian was extended still further by Biot and Arago.

The geographical engineers, successors of the astronomers of the Academy, have extended their work; they have based geodetic operations of the highest class upon a great series of triangles extending without interruption from Dunkerque to Formentera. This triangulation serves as a base for the great map of France, and as the beginning of that great system which, carried out since 1831 by the officers of the General Staff, forms triangulations of the second and the third order, which cover the entire territory.

For a long time the methods and observations of calcu-

lations established by Delambre and applied with success by his followers had been considered as attaining the limits of perfection. Abroad they have served as a point of departure for the new methods of Gauss and Bessel.

More lately, however, the introduction into geodetic science of the new methods, and the progress made in the construction of instruments, have brought our modern work to such a degree of perfection that we are forced to admit errors in the former French system.

With the object of eliminating these errors, the Ministry of War in 1869 ordered a new measurement of the meridian of France. This measurement, continued for 18 years under the direction of General Perrier, is now complete, and it will be supplemented by new measurements of the entire system, wherever the new meridian has shown errors. The work of revision of the base lines of the map of France will be completed by measurements of latitude, longitude, and azimuths, a part of which is already done.

In order to carry out these different works of great precision, and also to form the base of the new map of Algeria and Tunis, the Geographical Service has been obliged to renew its material of observation. The method of reiteration has replaced, in instruments intended to measure angles, the method of repetition, and the apparatus for measuring base-lines has been constructed on the new method invented by Porro, while to determine the coordinates the most delicate instruments and the most perfect methods have been borrowed from astronomers.

The perfection which has been obtained in instruments can only be realized from an inspection of the remarkable collection which forms the first part of the exhibit.

II.—CARTOGRAPHY.

The specimens of map work have been chosen in such a way as to form a general history of topography in France, from the beginning of the 18th century up to the present day.

In the historical exhibit there are placed all the works which preceded the publication in 1833 of the first volume of the great map of France to a scale of 1 : 80,000.

The modern exhibit is composed of all the maps prepared since that date.

This division is explained by the fact that the maps prepared since the Service passed under the charge of the General Staff of the Army mark a revolution in the history of topography.

In the 17th century and during part of the 18th century the conformation of the land was expressed on maps like a view in free perspective. This method, which for a long time retained partisans among distinguished geographers, consisted in putting in perspective the contour of the mountains, on little inclined planes gradually sloping down to the general plane. This was extended to the representation of rocks, woods, cities, villages and many other objects as far as their form and the scale of the map permitted. Bourcet's map of Dauphiné, dated 1760, is a type of the maps executed on this system.

Another plan used already before that date is that of lines of greatest fall. In this the geographer follows in imagination the curves which would be followed on the surface of the earth by a drop of rain or some other body subject to the laws of gravity. In this way the curves are determined and projected, so that the fall of the land is represented in every direction. This method, first used by Massé, Royal Engineer, in his map of Poitou, was followed by Cassini in his map of France.

The geographical engineers perfected this second method of representation, and adopted the principle of an oblique light, bringing strongly into relief the irregularities of the surface. The map of the Island of Corsica, on a scale of 1 : 200,000, may be considered one of their most remarkable works.

The map of France, on a scale of 1 : 80,000, is of the type of a fourth system, which is in reality only a modification of the one last described. The lines of engraving, following always the lines of greatest fall, are divided on a scale of falls established mathematically, but the light is supposed to strike the surface vertically and not obliquely.

For the last 20 years the method of representing the surface by horizontal curves or contour-lines tends to replace this method.

Moreover, the general preference at this time seems to be for maps printed in several colors, and there is also a demand for rapid execution. In consequence, the copper-plate engraving of maps is gradually going out of date, and is being replaced by lithographic work, by zinc etching or engraving, and by the various heliographic methods. Specimens of all these different kinds of work are included in the exhibit.

The chief feature of the exhibit is the magnificent map of France, on a scale of 1 : 80,000. The execution of this new map, intended to replace the old map of Cassini, the imperfections of which were realized, was ordered in 1817, and the geodetic and topographical work began in the spring of the following year. The primary and secondary triangulations were completed in 1854, the triangulation of the third order in 1863, the topographical work in 1866, and the engraving in 1882. The field notes, on the scale of 1 : 40,000, were made by the officers of the Corps of Geographical Engineers attached to the General Staff, and the reduction to the scale of 1 : 80,000 was made by the draftsmen in the office of the Staff. The most striking feature of this great work, the total engraved surface of which covers 100 square meters, is the fact that it represents in all over 5,000 years of work, contributed by more than 800 officers, geographers, topographers, artists and engravers, and, nevertheless, the execution is characterized by complete harmony. The 273 separate leaves which compose it, engraved by over 65 different artists, seem to be executed by the same hand.

The dimensions of the map of France on a scale of 1 : 80,000—43.30 ft. in width by 40.35 ft. in height—have not permitted its representation on a single sheet. The specimen shown represents the frontier of the Alps from Grenoble to Nice.

We must close by some remarks on the work undertaken of constructing a new topographical map of France on a scale of 1 : 50,000, in which the levels will be shown by equidistant contour-lines picked out with color. The specimen of this new map exhibited shows the northeastern frontier in the neighborhood of Metz.

The entire map when completed will consist of 950 sheets 25.20 × 15.75 in. in size. It is, in fact, the reproduction on this scale of the field notes made on the spot by the officers of the Staff, corrected from the geodetic work recently completed and now in progress. It will be engraved on zinc and printed in six colors. Red will be used for buildings and for roads regularly maintained and always passable for carriages. Black is used for roads not always passable, for municipal boundaries, farm divisions, etc., and for all lettering. The water is represented by blue ; forest or woodland by green, and the contour curves are drawn in mineral brown, picked out with bluish gray. The distances between the regular horizontal curves which express the contour of the surface is 32.8 ft. (10 meters), and the lines are lightly traced in order to prevent confusion of details.

From a practical point of view this map will present certain advantages over the existing ones. The use of different colors to represent hills and mountain land and the large scale will make it very easy to read. The representation of the surface by equidistant contour-lines will not hide, as the engraved lines do, especially in mountain districts, the details of the surface. And this method of representation will enable hereafter engineers, geologists and others to utilize the maps given out to the public, relieving them from the trouble they have been under heretofore of going to the office of the Geographical Service to obtain the preliminary plotting made from the field notes.

The exclusive use of contour-lines for the representation of mountains or hills presents the inconvenience of depriving them of relief and of making the different irregularities of the surface so much alike as to render a comparison by the eye almost impossible. If, for instance, in very rapid falls, the simple nearness of the curves is sufficient to give a certain relief to the general form, it is not the same in the less irregular parts of the surface ; there the eye has difficulty in following the lines and the map can only be read, for level country, by close and difficult study.

To obviate this inconvenience, which is found in all maps in which the contour-lines alone are used, the Geographical Service has sought to represent the outline of the surface by a careful variation of color, taken on the assumption of light falling vertically, and regulated in such a way that the shade is deepened directly in proportion to the fall. It has also endeavored to determine the shades of color in such a way as not to interfere with the other details of the map, and especially with the lines representing the system of roads. For this reason it has been decided that inclinations less than 1 : 40 shall not have any special color.

The coloring is executed by the lithographic crayon, and is made by a sixth impression plate.

The specimen shown has been executed after the principles described above, and has a most excellent effect in every way.

Finally it may be said that this exhibit of the Geographical Service of the Army is one of the most interesting in the Exposition, and does great honor to the officers under whose charge the work is conducted.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

BY M. N. FORNEY.

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(Continued from page 338.)

CHAPTER XXXIII.

RUNNING LOCOMOTIVES.

QUESTION 787. *Before starting the fire in a locomotive what should be observed?*

Answer. It should always be noticed before kindling the fire whether the boiler has the requisite quantity of water in it; that all cinders, clinkers and ashes are removed from the grates and ash-pan, and from the brick-arch or water-table, if the boiler has either of these appliances; that the grates and drop-door are in their proper position and securely fastened; that the throttle-valve is closed and the lever secured; and, if the boiler was filled through the feed-pipe by means of the engine-house hose, it should be observed whether the check-valves are closed. If they are not closed it will be shown by the escape of water when the engine-house hose is detached, or by the water and steam blowing back into the tank when the tender-hose are coupled up, and after steam is generated in the boiler. Locomotive boilers are sometimes seriously injured by building a fire in them when they have not been filled with water. This can only occur from the grossest carelessness on the part of the person who starts the fire, and is or should be a cause for suspension or discharge of the person who is guilty of such neglect. In filling a boiler it must be remembered, however, that when the water is heated it will expand, and that when bubbles of steam are formed they will mix with the water and thus increase its volume, so that after the water is heated its surface, as shown by the water-gauge and gauge-cocks, will be considerably higher than when it is cold.

QUESTION 788. *How should the fire in a locomotive be started?*

Answer. It should be started slowly, so as not to heat any one part suddenly. Probably the greatest strains which a locomotive boiler has to bear are those due to the unequal expansion and contraction of its different parts. When the fire is started, of course the parts exposed to it are heated first, and consequently expand before the others do. If the fire is kindled rapidly, the heating surfaces will become very hot before the heat is communicated to the parts not exposed to the fire. Thus the tubes, for example, will be expanded so as to be somewhat longer than the outside shell of the boiler, and therefore there will be a severe strain on the tube-plates, which will be communicated to the fire-box, stay-bolts, braces, etc. The inside plates of the fire-box will also become much hotter than those on the outside, and as they are rigidly fastened to the bar to which both the inside and the outside shells are fastened at the bottom the expansion of the inside plates will all be upward, which thus strains the stay bolts in that direction. As the motion due to this expansion is greatest near the top of the fire-box, the top stay-bolts are of course strained the most, and it is those in that position, as has already been pointed out, which are the most liable to break. When steel plates are used the expansion or contraction sometimes cracks them, and occasionally hours after the fire is withdrawn from the fire-box, the inside plates will crack with a report like that of a pistol. It is, therefore, very important both to heat and cool a locomotive boiler slowly, and it is best to kindle the fire several hours before the engine starts on its run.

QUESTION 789. *If the fire in the fire-box has been banked, what should be done before leaving the engine-house?*

Answer. The fire should be broken up with a bar and the ashes shaken out of it, and fresh coal should be thrown on the fire if it is needed.

QUESTION 790. *What should be done when the locomotive leaves the engine-house and before the train is started?*

Answer. Before leaving the engine-house the cylinder cocks should be open, so that any water or steam which is condensed in warming the cylinders can escape. The engineer should know that the tank is filled with water, the sand-box with sand, and that there is a proper supply of oil, waste, packing, tools, and lamps on the engine. Before the engine is started from the engine-house the bell should be rung and time enough allowed for any workmen employed about the engine to get out of the way. This rule must be scrupulously obeyed under *all circumstances*, and a locomotive should *never* be started without first giving such a signal. Without it there is always danger that some one about the engine will be hurt or killed. While running from the engine-house to the train the engineer should observe very carefully the working of all the parts of his engine, and as far as possible see that they are in good working condition. If the engine is without a steam or air brake, the fireman should operate the hand brake on the tender when it is needed. The junction with the train, especially when it is a passenger train, should be made very gently, as otherwise passengers may be injured by the shock. Before starting the engineer should see *himself* that the engine and tender are securely coupled together, that the frictional parts are properly lubricated, as explained heretofore, that the fire is in good condition, and that the requisite quantity of steam has been generated. If the steam is too low, the blower should be started, which stimulates the fire. He should also test the air-brakes, as explained in another chapter.

QUESTION 791. *When the train is ready, how should the engine be started?*

Answer. After the signal to start is given by the conductor, the engineer also gives a signal by either ringing the bell or blowing the whistle. The latter should, however, be used, especially at stations, as little as possible, on account of the risk of frightening horses and the shock which it produces on persons who are unaccustomed to hearing it, or are suffering from any nervous disorder. After giving the requisite signal, the engineer places the reverse lever so that the valve will work either in full gear or very near it. He then opens the throttle *slowly* and *cautiously* so as to start the train gradually. If the train is a very heavy one, it is best to back the engine so as just to "take up the slack of the train"—that is, to push the cars together so that there will be no space between them, and thus compress the car draw-springs. When the cars stand in this way, those at the front end of the train are started one after another, which makes the start easier than it would be if it were necessary to start them all at once. If the throttle is opened too rapidly, the driving-wheels are apt to slip, but with a very heavy train, even with the greatest care, this is liable to occur. If the train cannot be started otherwise, the rails must be sanded by opening the valves in the sand-box. As little sand should be used as possible, because the resistance of cars running on sanded rails is greater than on clean rails, and thus the train is more difficult to draw after it reaches the rails to which sand has been applied. The difficulty to be overcome may thus be increased by the means employed to overcome it.

While the train is slowly set in motion the fireman and engineer should ascertain by watching whether the whole train moves together, and that none of the couplings are broken in starting, and also whether any signal is given to stop, as is sometimes necessary after the train has started. On leaving the station he should observe whether all the signals indicate that the track is clear and that the switches are set right, and also look out for obstructions on the track. The train should always be run slowly and cautiously until it has passed all the frogs, switches and crossings of the station yard, and not until then, and when the engineer has seen that everything is in order, should he run at full speed. As the engine gains in speed the reverse lever should be thrown back and nearer the center of the quadrant or sector, so as to cut off "shorter."

QUESTION 792. *After the engine is started, how can it be run most economically?*

Answer. The advantage of using steam expansively has already been explained in Chapter V; it is more economical to use steam of a high pressure, which is done by keeping the throttle-valve wide open, and then regulating the speed by cut-

ting off shorter—that is, expanding it more—than it is to throttle the steam. If the speed is reduced by partly closing the throttle-valve, the steam is wire-drawn, and, as was shown in answer to Question 101, it then produces less useful effect than it would if it was admitted into the cylinder at full boiler pressure.

There is also another practical difficulty in using steam of a high pressure and running with the throttle wide open and regulating the speed with the reverse lever alone. The link-motion, as has already been explained, will not be effective in cutting off at a point below about one-quarter of the stroke. Now it often happens, even when cutting off at that short point, with light trains on a level or slightly descending grade, that the speed will be too great if the throttle is wide open and with full steam pressure in the boiler. When this is the case, it is absolutely necessary to reduce the speed by partly closing the throttle. Undoubtedly if valve-gear for locomotives was so constructed that steam could be cut off effectively at a shorter point of the stroke, it would result in some increased economy in the use of steam.

The engineer should aim to run at as nearly uniform speed as possible, and in order to do so should divide the distance between stopping points and the time given for running it into as small divisions as he conveniently can, so as to be able to tell as often as possible whether he is running too fast or too slow, and thus travel over the shorter spaces in corresponding periods of time.

QUESTION 793. *How should the boiler be fed?*

Answer. The feeding of the boiler should, if possible, be continuous, and the quantity of water pumped into it should be adjusted to the amount of work which the engine is doing. Ordinarily one pump or injector is more than sufficient for feeding the boiler, so that usually only the one on the right side of the engine, where the engineer stands, is used. The flow of the water with a pump is regulated by partly opening or closing the feed-cock. In feeding the boiler it must be seen that the water is neither too high nor too low. If it is too low there will be danger of overheating the crown-plates or even of an explosion; if it is too high, the steam space in the boiler is diminished unnecessarily, and will cause the water to rise in the form of a spray, and thus be carried into the cylinders with the steam, or the boiler will *prime* or *foam*, as it is called. This water, if it collects in the cylinder as already explained, may by the concussion produced by the motion of the piston break the cylinder.

QUESTION 794. *What is the cause of priming in a boiler?*

Answer. One of the chief causes of priming is impure water. If grease, oil, or soap gets into the boiler, it is almost sure to cause priming. Mud or other dirt is also liable to cause it. It is often due to the difference in the temperature and pressure in the water below and the steam above. Thus, if we have a boiler in which the water is heated to a temperature due to 150 lbs. effective pressure, or 366 degrees, and we then open the throttle-valve suddenly, so as to relieve the pressure on top of the water, there will at once be a rapid generation of steam in the water which will rush to fill the space from which the steam has been drawn, just as the gas in soda water will rush toward the mouth of a bottle when the cork is drawn. This newly-generated steam will be formed at the hottest part of the boiler first—that is, next to the heating surface. It will, therefore, happen that as soon as the pressure is relieved, bubbles of steam from all parts of the heating surface of the boiler will flow to the point at which the steam escapes. The motion of these bubbles will be so rapid that large quantities of water will be carried with them. The same thing will also occur if the heat of the water is increased very rapidly. The water will then become hotter than the temperature, due to the pressure of the steam above it, and consequently there will be a rapid formation and escape of bubbles of steam from the water, which will thus have the same effect as they would have if the steam pressure was reduced.

The amount of water carried up with the steam is increased if the escape of the latter is obstructed in any way, owing to imperfect circulation of water in the boiler, or by floating impurities, such as oil, on the surface. When this condition of things exists, the ebullition is, as it were, convulsive, and the water is thus carried up with the steam when it escapes. Priming is also probably due in some measure to the flow of steam over the surface of the water to the point of outflow,* carrying particles of water with it just as a high wind will, when blowing over the crests of the waves of the sea.

When steam is drawn, as it usually is in locomotives, from the top of the dome to which the safety-valves are attached, the tendency to prime is very much increased when they are blowing off, so that some engineers advocate the use of two domes, from both of which the supply of steam is sometimes drawn, and in other cases the safety-valves are mounted on one, and the steam-pipe is placed in another dome. Whenever the safety-valves begin blowing off steam, the pressure in the boiler should be reduced as soon as possible, not only because when they are blowing off it tends to produce priming, but because the steam which escapes from them is wasted. The pressure can be most economically reduced either by increasing the amount of water which is fed into the boiler, or by opening the heater cocks and allowing the steam to escape into the tank and thus warm the water in the tank. If the boiler is too full, the former method cannot be employed, and in heating the water in the tank the engineer must be careful not to get it too hot, because in that case neither the pumps nor the injectors will work satisfactorily, and the paint on the tenders is also liable to be blistered and destroyed by the heat. By feeling the tank with the hand it can soon be discovered whether the water is too hot. If the steam pressure cannot be reduced in any other way, the furnace door must be partly opened.

The use of muddy water will also sometimes cause a boiler to prime. It is probable that priming is sometimes due to the formation of foam on the surface of the water, and therefore all priming is often called foaming; whereas it is thought that often a boiler will prime when the water does not foam. More accurate information regarding the priming of boilers is, however, much needed, as many of the phenomena have thus far not been satisfactorily explained. The principal causes of priming in ordinary practice are, however, undoubtedly owing to defective circulation, too little steam room, impure water, or too much water in the boiler.

QUESTION 795. *How can it be known whether an engine is priming, and what should be done to prevent it?*

Answer. The priming of a boiler can be known by the white appearance of the steam which escapes from the chimney and the cylinder cocks. Dry steam always has a bluish color. When an engine primes or works water into the cylinders, it is usually indicated by a peculiar muffled or dead sound of the exhaust, which from this cause loses its distinctly defined and sharp sound. This can be observed best when the furnace door is opened. It is also indicated by the discharge from the gauge-cock, as the steam from the upper cocks is not clear, but is mixed with water. To use a phrase employed by practical men, the priming or foaming of the boiler may be known by the "flutter" of the gauge-cocks. The water will also rise in the glass water-gauge, and it will not indicate correctly the quantity of water in the boiler. As soon as there are any indications of priming, foaming, or that water is working into the cylinders, the cylinder cocks should be opened at once, otherwise the cylinders, cylinder heads, or pistons may be broken. The throttle-valve should be either partly or entirely closed. When the latter is done the foaming will in most cases cease for the time, so that the engineer can tell how much "solid" water there is in the boiler. When the flow of steam from the boiler is stopped the priming usually stops, and the true level of the water will be shown by the gauge-cocks and glass water-gauge. If it is found that there is too much water in the boiler, it is best to shut off the feed, and in some cases the blow-off cock should be opened. The latter is, however, attended with some danger, because if any obstruction should get into the blow-off cock, or it should stick fast, so that it could not be closed, all the water would escape from the boiler, and with a heavy fire in the fire-box there would be great danger of overheating, and thus injuring the boiler or of "burning" it, as it is ordinarily termed. In that event it will be imperative to put out the fire at once. Another method of affording relief, if a boiler foams, is to place what is called a *surface-cock* in the back end of the fire-box, about half way between the upper and lower gauge-cocks. With such a cock, the water can be blown off from the surface instead of from the bottom. As foaming or priming is often caused by oil or other floating impurities on the surface, they can be blown out of the boiler with this arrangement, whereas, if the water escapes from the bottom of the boiler, the floating impurities will always remain after it is blown off. A perforated pipe, which extends for some distance along the surface of the water inside the boiler, is sometimes attached to the surface-cock, so that the water which is blown off will be drawn from a number of points along the surface. If it is essential to keep the train in motion when the boiler foams, it is a good plan to place the reverse lever in full gear and open the throttle-valve very little, so as to diminish and equalize the flow of steam into the cylinders.

If the steam is rising rapidly when foaming begins, it will be well to cool the boiler off by opening the furnace door part way. This means of relief, as mentioned before, should, however, be used as little as possible, because there is always danger of causing the tubes or other parts of the boiler to leak, by either heating or cooling suddenly or rapidly. If the engine primes when there is but little water in the boiler, and at a time when the steam

* Wilson on Steam Boilers.

is rising rapidly, it may sometimes be remedied by increasing the amount of feed-water, and thus partly cooling the water inside. The use of pure water, careful firing so as to keep the steam pressure regular, feeding the boiler so that the level of the water will be nearly uniform, and then starting the engine carefully —that is, opening the throttle-valve gradually, are the most effective means in practice of preventing a locomotive boiler from priming.

QUESTION 796. *What is the economical effect of priming on the consumption of fuel in locomotives?*

Answer. It causes a great waste of heat, first by the escape of that contained in the hot water which passes through the cylinders and which does no work, and second, when steam is mixed with a great deal of water, it will not flow either to or from the cylinders as quickly or easily as dry steam will. Consequently the initial pressure on the piston, if the engine is running even moderately fast, and is cutting off short, will not be so great as it would be if dry steam was used. Wet steam is also more difficult to exhaust from the cylinders than that which is dry, and therefore the back pressure on the piston is greater when the boiler primes than when dry steam alone is used.

QUESTION 797. *When running on the open road, what should the locomotive engineer observe?*

Answer. Either he or the fireman should *constantly* watch the track in front of them, and also observe, from time to time, whether the train of cars, especially if it is a long one which he is handling, is in good condition. HE MUST OBSERVE EVERY SIGNAL SCRUPULOUSLY, AND SHOULD NEVER PASS ONE UNTIL HE IS SURE THAT HE IS AUTHORIZED TO DO SO. The well-known maxim, "Be sure you are right; then go ahead," should be changed for locomotive engineers to, DON'T GO AHEAD UNTIL YOU ARE SURE YOU ARE RIGHT, AND WHEN IN DOUBT ALWAYS CHOOSE THE SIDE OF SAFETY. In running through a curve, the speed of the train should always be moderated in proportion to the sharpness of the curve, and before reaching it, as the train has a tendency to continue in a straight line, and there is thus danger of running off the track. The higher the speed, of course, the greater is the resistance which is required to prevent the train from running in a straight line, and consequently the greater is the strain which is thrown on the flanges of the wheels and on the rails and axles. On a curve it is also impossible, usually, to see further than a short distance ahead, and therefore, if the train is running very fast, it cannot be stopped in time, should there be any obstruction or danger on the track.

QUESTION 798. *What precautions should be observed in running over steep grades?*

Answer. On approaching an ascending grade the fireman should see that the fire is in good condition, and as much coal should be put on it as can be burned to advantage. The engineer should also fill the boiler as full of water as he safely can, without danger of priming, and should heat this water as hot as possible without blowing off steam at the safety-valves. The object of this is to have a supply of water already heated before reaching the grade. If, as often happens with a heavy train, the boiler will not make as much steam as the engine consumes, if there is a large supply of hot water in the boiler it can be used as a reserve, should it be necessary to do so, without danger of injury to the boiler. If there was so little water in the boiler that it would be dangerous to allow it to get lower, then it would be necessary to feed cold water as rapidly as the hot water escaped in the form of steam. When the engine is working hard, it is often impossible to heat all this cold water as fast as it is pumped into the boiler, without reducing the steam pressure until there is not sufficient power to pull the train. If, however, there is a supply of hot water in the boiler, at the critical point on the grade, where the engine is most liable to fail, the pump or injector can be partly shut off, and thus less water will be fed into the boiler, and the steam pressure will be maintained without danger. Undoubtedly it is better to feed locomotive boilers uniformly, if that is possible, but it often happens that a reserve supply of hot water in the boiler enables an engine to pull a train up the most difficult place, whereas, without such a supply, the locomotive would stick fast. As the capacity of locomotives is rated on nearly all roads by the number of cars they can "pull up the hill," of course whatever aids them at the critical point increases their capacity. This fact gives engines with large boilers much advantage over those with small ones.

In running up steep grades, allowance should alwaysbe made for the effect of the inclination of the track upon the position of the water surface in the boiler, and also the fact that as soon as the throttle-valve is closed, and steam shut off, the surface of the water will be considerably lower than when the engine was working hard. On a grade of 50 ft. to a mile, the front end of the tubes of an ordinary locomotive would be about 2 in. higher than the back end of the crown-sheet. If, then, on working hard up such a grade, it is succeeded by another of equal descent, the front ends of the tubes would be 2 in. *lower* than the back end of the fire-box, so that if the crown-sheet was covered with 2 in. of water just before reaching the top, it would be exposed to the fire as soon as the engine reached the descent. This exposure would be dangerous, because not only would the water be 2 in. lower over the crown-sheet, but it would fall considerably more when the throttle-valve was closed. These considerations will show the danger of running the water too low while ascending steep grades.

In pulling trains up steep grades, especial caution should be exercised to prevent any of the cars from breaking loose from the train, because such an accident may cause great disaster.

If the engine is not equipped with an automatic cylinder oiler, as soon as the top of the grade is reached the fireman should oil the main valves, because it can only be done when steam is shut off, as the oil will not run into the steam-chest when there is a pressure of steam in it; and as the valves are always subjected to the severest wear while pulling up a steep grade, the valves and valve-faces are apt to become dry. As saturated steam to some extent prevents valves from cutting, it is not so important that they be lubricated while the engine is working with steam, but as soon as steam is shut off they should be oiled, otherwise there is danger of their being injured by their friction on the valve-seats.

In running down grades, the engineer has the greatest possible cause for using every precaution, because not only is the train much more difficult to control, but usually frequent sharp curves prevent a view of the track for any considerable distance ahead. He should, therefore, watch the track in front of him with the greatest vigilance, so as to be ready to give the requisite signals to the brakemen to apply the brakes, or, if the engine and train are provided with continuous brakes, to apply the latter, or even reverse his engine, in case of danger.

QUESTION 799. *What must be done on approaching a drawbridge or a crossing of another railroad at the same level?*

Answer. In many of the States it is provided by law that all trains must come to a *dead stop* before crossing a drawbridge or another railroad at the same level. When interlocking signals are provided at such places it is not considered essential to stop, but the engineer should then be absolutely certain that the signals indicate that the line is clear, and he should approach such places with his train under sufficient control, so that he can stop it in case of danger. The train should under no circumstances run up to such points until a signal has been given that the line is clear. An engineer should *never assume* that the signal has been given, nor take another person's word for it, but should see and know it himself. In some conditions of the weather, and with the light falling on a signal in certain directions, it is sometimes difficult to determine its color or form. If there is any doubt about it, the testimony of another person should always be sought. There is good reason for believing that color-blindness – that is, an incapacity for distinguishing one color from another, is a more common infirmity than is usually supposed. It is certain, too, that people who ordinarily distinguish colors very accurately are subject to color-blindness in certain conditions of health, and that it is sometimes the result of overwork or great weariness; and a case is recorded of a person who was always color-blind after a debauch. There are, therefore, good reasons why a locomotive engineer should not always place too implicit confidence in what he "sees with his own eyes," but if he has any doubt, he should take the "benefit of the doubt," which should always lead him to take the side of safety.

QUESTION 800. *How should the engine and train be managed in running into a station?*

Answer. First of all, when running into a station, when the train stops the speed must be checked so that the train will not enter with very great momentum. Therefore, at a distance varying, according to the nature of the grades and track, the steam should be shut off, so that the speed will be reduced so much that the train under any circumstances will be under full control. It is always better to enter a station at too low a speed than to run in too fast, because if it is necessary, more steam can always be admitted to the cylinders to increase the speed before coming to a stop; whereas it is not so easy to stop the train if it is running too fast, and it becomes necessary to check it before entering the station. This will sometimes be necessary, because it may readily happen through negligence or accident at stations that in switching cars one or more may be left standing wholly or partly on the track, which the arriving train must run over, in which case a collision, with its terrible consequences, may be unavoidable. When steam is shut off the reverse lever should be thrown into full gear, because in that position there is less compression of steam in the cylinders, and therefore not so much liability of raising the valve from its seat.

When a train is equipped with continuous brakes, the control which they usually give to a locomotive engineer over the train

is so great that he is apt to approach stations, crossings or drawbridges at a high rate of speed, and rely on such brakes to stop the train. This practice is always attended with danger, because if it was found, on getting near to the station, crossing or drawbridge, that the track was not clear, and that it was obstructed by a car or train, or the draw was open, if the engineer should attempt to apply the brakes and from some cause they should fail to work, as sometimes occurs, then a collision or other disaster would be inevitable, because it would be impossible to stop the train with the ordinary hand-brakes. For this reason a locomotive engineer should always approach such places cautiously and with his train under sufficient control, so that if he finds there is danger ahead he can stop the train with the ordinary means, or at the worst by reversing the engine. Continuous brakes should always, excepting in cases of imminent danger, be applied gradually, so as not to check the cars with a jerk or too suddenly. The practice of opening the engineer's-valve, which was formerly used with the Westinghouse brake, suddenly, and then turning it back again as quickly, is almost sure to produce disagreeable and dangerous shocks to the cars. This cock should be opened gradually, so as to check the cars slowly at first. The new engineer's-valve, illustrated and described in answer to Question 647, is arranged so that air can be turned on and shut off quickly without producing disagreeable shocks.

QUESTION 801. *What must be attended to when running a locomotive at night?*

Answer. As soon as it begins to grow dark, the head-light must be lighted and properly trimmed, and the proper lamp signals placed in front of the engine, if the rules of the road require the display of such signals. A lamp should always be placed in the cab, so as to throw its light on the steam-gauge, but not into the engineer's face, because he is unable to see distant signals so well if his eyes are exposed to the glare of a light near him.

At night, as objects which are passed cannot be seen distinctly, it is more difficult to tell the speed at which an engine is running than it is in the daytime. An engineer should, therefore, consult his watch frequently.

QUESTION 802. *What must be attended to in very cold weather?*

Answer. Great care must be exercised to prevent the water in the pumps, pipes and in the tender from freezing. If it does it will be almost certain to break the pump or burst the pipes. To avoid this the heater cocks must be opened, so as to keep the water in the tender warm. In excessively cold weather the engine should be run with greater caution than at other times, as iron is then more brittle, and also more liable to break, owing to the frozen condition and consequent solidity of the track.

QUESTION 803. *In running a locomotive in severe snow or rain-storms, what should be observed?*

Answer. Whenever it snows the pilot or cow-catcher should be covered with boards, or, better still, with sheet iron, so as to act like a snow plow. Brooms made of steel wire or scrapers should be placed in front of the front wheels of the engine, so as to clean the snow from the rails. The front damper on the ash-pan should be kept closed so as to exclude the snow from the ash-pan, which would soon fill it up, and in this way obstruct the draft. If the fall of snow is very heavy or it blows into drifts, the train must of necessity run very slowly, and even if a part of the track is clear of snow, it is unsafe to run fast on it, as there would be danger of throwing the engine off the rails, if it should run into a heavy drift at a high speed.

In severe rain-storms bridges, culverts, and such portions of the track as are liable to be washed away should be approached cautiously, especially at night. In both snow and rain-storms, and also in fogs, great caution is required, owing to the difficulty of seeing signals.

QUESTION 804. *What is meant by a reserve engine or "helper?"*

Answer. A *reserve engine* is a locomotive which is not employed in hauling a regular train, but is kept as a "reserve" to go to the help of an engine which may be compelled to stop on account of an accident of any kind, or to assist engines in moving trains up heavy grades, or is used in clearing away a wrecked train, rebuilding bridges, or other structures.

QUESTION 805. *What must be observed in running a reserve engine?*

Answer. As no special arrangements are usually made in preparing time-tables * for the running of reserve or, as they are usually called by railroad men, "*wild*" engines, it may very probably happen that it will be called upon to assist other engines when the road is not clear, and therefore its engineer must constantly be on the lookout for signals to stop, which are often given suddenly. He must switch off with special caution in order to be sure to keep out of the way of regular trains running in the opposite direction on the same track. When he reaches the train or place where the assistance of the reserve engine is needed, he must approach it *slowly* and *carefully*, in order to avoid a violent shock. On the return from the assisted train, he incurs the same danger, and must pay close attention to any signal to stop made to him by any opposite train on the same track, and also on his part warn such trains by the proper signals.

When a train is run with two engines, both in front of it, the forward one always takes the management of the train. The engineer of the hind engine must be guided by the signals of the engineer of the forward engine. In starting, the forward engine must be set in motion first and then the one behind it. In stopping, the steam must be shut off first in the hind engine. Likewise in decreasing the speed during the trip, the hind engine must first regulate the flow of steam. If these precautions are not observed the forward engine may easily be thrown from the track by the faster motion of the hind one. When there are two engines the air-brakes should always be operated from the front engine, but the air-pump on the rear one should be kept running to assist in charging the brake reservoirs with compressed air. When a train is assisted by a "helper" placed *behind* the train, and therefore pushing it, the forward engine must likewise be set in motion first, and steam should be let on in the hind engine only after a signal has been given by the engineer of the head engine. During the run both engines must move with the same speed.*

QUESTION 806. *How should switching engines be managed?*

Answer. In pushing and switching freight cars in a station-yard, they should be moved carefully and severe shocks must be avoided, as the cars, the goods with which they are loaded, and the persons employed about them may be injured by violent concussions. The engineer must also follow the instructions of his superior *strictly* and *cheerfully*, and should examine patiently and observe with discretion the suggestions of employés who are not his superiors.

In this service it is also of special importance that the engineer give a *distinct* signal with the whistle or bell before every movement of his engine, in order to warn in time those who at such times often stand on the track in the way of the engine or cars, or the persons engaged in loading, cleaning, or repairing the cars, and thus give them time to get out of the way.†

QUESTION 807. *In firing a locomotive, what are the most important ends to be attained?*

Answer. That which is of first and chief importance is to make steam enough, so that the locomotive can pull its train and "*make time*" ‡; second, it should make the requisite quantity of steam with the least consumption of coal, and third, with the least production of smoke, although the latter, independent of the economy of combustion, is considered of importance only with passenger trains. What is frequently lost sight of in considering this subject is the fact that with all locomotives it often happens that it is a matter of extreme difficulty to make enough steam to do the work required of the engines. When a freight train is struggling up a grade with a heavy train, or an express engine is obliged to make time under similar conditions, it often depends entirely upon the quantity of steam which can be generated in the boiler in a given time whether the engine will fail or not. In firing, therefore, the most important end to be aimed at is often simply to produce the largest amount of steam possible in a given time, even at the sacrifice of economy or by producing any quantity of smoke. Any means of economizing fuel or of smoke prevention, which reduces the steam-producing capacity of boilers, is therefore quite sure to be abandoned in time.

QUESTION 808. *How can a boiler be made to produce the largest quantity of steam in a given time?*

Answer. By burning the greatest quantity of fuel possible on the grate in that time. This can be done by keeping the grates free from clinkers and the ash-pan from ashes, and then distributing the coal evenly over the grates in a layer 6 to 12 in. thick. The thickness of the layer which will give the best results will, however, vary with the quality of the fuel, and must be determined by experience. If the layer is too thick, not enough air will pass through it to burn the coal. If it is too thin, then so much air will pass through that the temperature in the fire will be reduced. The rapidity of combustion will also be promoted by breaking up the coal into lumps the size of a man's fist or smaller. If fine coal is used it should be wet, otherwise it will be carried into the flues by the blast before it is burned,

* A *time-table* is a table which gives the time when each train shall arrive at the stations it passes, the stations at which it shall stop, and all the regulations by which it shall be run.

* Katechismus der Einrichtung und Betriebes der Locomotive, by Georg Kosak.

† Georg Kosak.

‡ The term *make time* means to run at the speed indicated on the time-table.

or caked, or even reaches the grate. Experience will indicate the amount of air which can advantageously be admitted above the fire in order to secure the maximum production of steam. The best size of the exhaust nozzles and the position of the petticoat-pipe must also be determined by experience. It will usually be found, however, that if enough air is admitted above the fire to prevent smoke, it will reduce the maximum amount of steam which can be generated in a given time. The fire should also be fed regularly and with comparatively small quantities of fuel at a time, although if the feeding is too frequent there is more loss from the cooling effect which results from the frequent opening of the furnace door than is gained from the regularity of the firing. In this, too, a fireman must consult experience to guide him.

QUESTION 809. *How can a locomotive be fired with the least consumption of coal?*

Answer. Two systems of firing are practised in this country, one known as the "banking system" and the other the "spreading system." When the banking system is employed, the coal is piled up at the back part of the fire-box, as shown in fig. 346, and slopes down toward the front of the grate, where the layer of coal is comparatively thin and in an active state of incandescence. The heap of coal behind is gradually coked by the heat in the fire-box, and the gases are thus expelled. Openings in the furnace door admit air, which mingles with the escaping gases, which then pass over the bright fire in front, and are thus supposed to be consumed. When the "bank" of coal behind becomes thoroughly coked, it is pushed forward on the bright fire and fresh coal is again put on behind to be coked. This system of firing is practised on some roads with good results, but it is doubtful whether it could be used successfully with coal which cakes and clinkers badly.

The spreading system is most commonly employed in the Western States, where the coal contains a great deal of clinker. When this is practised, the coal is spread evenly over the whole of the grate in a thin layer, and its success and economy depend upon the regularity and evenness with which this layer of coal is maintained and the fire fed. The thickness of the coal must be adapted to the working of the engine. When it is working lightly, the layer of coal should be thin, but when the engine is pulling hard the layer of coal must be thicker, otherwise the violent blast may lift the coal off the grates. The success of this system, as was explained in answer to Question 567, depends upon the manner in which the thickness of the fire is regulated, on the admission of the proper amount of air above the fire, and on the frequency with which the fire is supplied with coal. When this system of firing is employed not more than two shovelsful of coal should be put into the fire-box at once, and if the engine is not working hard, one or even less will be sufficient. The fireman must, however, determine by experience the thickness of fire, amount of air which should be admitted and the frequency of firing which will give the best results in practice. Doubtless these will vary with different kinds of fuel and the construction of engines. Usually the greatest obstacle in the way of producing good results is the fact that firemen would rather "take things easy" than exercise that diligence and observation which will alone insure success in any occupation.

QUESTION 810. *How can smoke be most effectually prevented?*

Answer. The means of preventing smoke were very fully explained in answer to Questions 580 and 581. It may be said briefly that this can be done only by properly regulating the supply of air which is admitted to the fire. The means of doing this have already been explained.

QUESTION 811. *What method of firing is employed when anthracite coal is used?*

Answer. The spreading system alone is then used.

QUESTION 812. *How may the rules which firemen should observe when bituminous coal is used be briefly stated?*

Answer. (1) Keep the grate, ash-pan and tubes clean. (2) Break the coal into small lumps. (3) Fire often and in small quantities. (4) Keep the furnace door open as little as possible. (5) Consult the steam-gauge frequently, and maintain a uniform steam pressure, and if necessary to reduce the pressure do it by closing the ash-pan dampers rather than by opening the furnace door.

QUESTION 813. *On arriving at a station where a train stops longer than a few minutes, what should the locomotive engineer and fireman attend to?*

Answer. The engineer should examine thoroughly all the parts of his engine, as has been heretofore explained. He should especially examine all the journals and wearing surfaces to see whether they are hot. This he can discover by feeling them. If any of them have become very much heated, they must be cooled by throwing cold water on them, and then thoroughly oiled. The working parts should be thoroughly lubricated, as already explained.

The fireman should examine the tank and see whether it is necessary to take in a fresh supply of water. He should then examine the grates and ash-pan, and clean the cinders and clinkers from the former, and the ashes from the latter. Neglecting to clean the ash-pan may result in melting and destroying the grate-bars, and by obstructing the admission of air to the grates, the ashes prevent the combustion from being as complete as it would be otherwise. With some kinds of fuel it is necessary to clean the tubes frequently, which must often be done at stations where the train stops.

During the stop, as thorough an inspection of the engine should be made by the engineer and fireman as the time will permit; but any unnecessary waste of time must be avoided, and the firing should be so managed that nothing need be done about it during the halt at the station. On starting again the same precautions should be exercised as on making the first start.

QUESTION 814. *After reaching the end of its run, how should an engine be cleaned and repaired?*

Answer. Before reaching the last station the firing should be so managed that there will be as little fire as possible remaining in the fire-box at the end of the run. After the arrival the engine should be run over a pit which is usually provided for the purpose, and the fire should be raked out of the fire-box by dropping the drop-door, if there is one to the grate, or turning the grate-bars edgewise, or withdrawing one or more of them, if it is necessary to do so. In this way the fire will fall into the ash-pan, from which it can easily be raked. After all the fire is withdrawn the dampers and furnace door should be closed so as not to allow the cold air to cool the fire-box and tubes too rapidly.

In order to keep the boiler clean—that is, as free as possible from sand, sediment or incrustation, it is necessary to blow it out frequently, if the water which is used contains much solid or incrustating matter. With "bad water" the boiler should be blown out as often as possible. On some roads this is done after each trip. In blowing a boiler out, the blow-off cocks must be left open, and after all the water has escaped the engine should be left to stand until it is cooled off. If there is any considerable accumulation of mud or sediment the hand-holes at the bottom of the fire-box and the cover to the mud-drum should be taken off, and as much of the mud removed as can be scraped out through those apertures. A hose-pipe attached to the hose of a force pump should then be inserted through these same openings, and a strong stream of water forced into the boiler. By this means much of the loose mud and scale will be washed out. The oftener this is repeated, of course, the cleaner can a boiler be kept. If a large amount of incrustation or mud has accumulated about the tubes, some or all of them must be taken out, so as to be able to remove the dirt.

After an engine is blown out, under no circumstances excepting absolute necessity should it be filled with cold water until it is cooled off. It should be remembered that any sudden change of temperature in a boiler subjects it to very great strains and incurs the danger of cracking the fire-box plates, or causing the tubes to leak.

The tender should also be cleaned of the mud which settles in it from time to time, but it is not necessary to do this as often as it is to clean the boiler. The strainers in the tank over the water-supply pipes should be examined and cleaned frequently. All the plates and flues should have the soot which sticks to them thoroughly cleaned off.

Although the cleaning of the boiler and the grates is usually committed to a special set of men, yet the locomotive engineer should examine them personally to see that it is properly done. He should pay attention to the condition of the grate, and see whether it is level and smooth. As soon as one or more of the bars are bent crooked, they usually burn out. If one of the bars is burned out the fire falls through the hole that it leaves into the ash-pan, and then the fire under the grate will heat it red hot, and finally may melt every bar. Every grate-bar which is only a little damaged or bent must therefore be removed as quickly as possible and replaced with a new one. An opening in the grate larger than the spaces between the bars allows a superfluous amount of cold air to enter the fire-box, and diminishes the steam-generating capacity of the boiler.

As soon as the engine is run into the engine-house, the cylinder cocks should be opened and left open while it is standing still, so that the condensed water can escape. All superfluous grease which has escaped from the wearing surfaces and the dust or mud which adheres to the engine should be wiped off with cotton waste or rags. This is usually done by men employed for the purpose. While they are doing this, they should examine every part thoroughly and observe whether it is in good condition, and if any defects are found they should be reported to the proper person whose business it is to have them repaired. As the faithfulness and skill of a fireman are often

estimated by the good or bad condition of his engine, he should, if for no other reason, take pains to keep it clean and everything in as good condition as possible.

If the engine is taken to pieces in order to be thoroughly repaired, the engineer, if he does not help to do this, should watch carefully the taking it apart and the putting it together again, as in this way he can become thoroughly familiar with the construction of the machine he runs.

QUESTION 815. *What precaution must be taken to prevent the water in a locomotive from freezing, if it is laid up?*

Answer. In very cold weather, if engines are laid up for any considerable time, no water must be left in the tender, boiler or any of the pipes. If, however, the engine must be soon used, and it is impracticable to let the water out of the boiler and tender, then, if exposed to the cold, a light fire must be kept in the boiler sufficient to make steam enough to warm the water in the tender. The water should, however, be drawn out of the pumps, injectors and the feed and supply pipes. This can be done by opening the pet-cocks, and closing the tender valves and uncoupling the hose, which will allow the water in the supply pipes to run out. By running the engine a few revolutions the pumps will then be emptied. The pipes and the pumps can also be prevented from freezing without uncoupling the hose, if the tender valves are closed and the pet-cocks opened, and steam is then admitted into the supply pipes by the heater-cocks. This forces part of the water which is in the pumps out of the pet-cocks and warms the rest. This, however, requires constant watchfulness to prevent freezing, and in excessively cold weather, if the engine must lay up for any considerable time, it is always best to empty the pumps and pipes.

(TO BE CONTINUED.)

Manufactures.

Udstad's Metallic Packing.

THE packing shown in the accompanying illustration has been tried and well tested on steam-engines and pumps, and has attracted considerable attention.

In fig. 1, *A A* are metallic rings of crescent-shaped section and *B B* rings of circular section made of some elastic composition. At present, the rings *B B* are made of canvas with a large rubber core.

The objects sought in designing this packing were as follows:

1. To make a packing which could be applied to any engine or pump without altering the present stuffing-boxes and glands.

2. To provide for some lateral motion of the rod in the stuffing-box. This is accomplished by the packing rings *B B*, which are protected from the direct action of the steam, and will thus always retain their elasticity. A proof that this claim is justified was shown in an engine to which the packing had been applied. The condensed water had not been properly drained off from the cylinder before starting the engine, and the piston, moving toward the back end first, had its motion suddenly arrested by the water, but the impact was partly relieved when the packing opened up around the rod, allowing part of the water to escape, and thus probably saving the cylinder-head.

3. To provide a number of angular grooves in the face of the packing, thereby making the steam condensed on the rod act as a lubricant.

4. To make a packing cheap in first cost, durable, and easy to repair or renew. The metallic rings are cut open at one place, as shown in fig. 4, and they are placed on the rod by partly opening them and twisting them sideways; afterward they are easily brought back to their original shape. These rings are made of Babbitt metal, of such composition as experience had shown to be best for this purpose. To ascertain if the rings could be decreased sufficiently by compression, a new ring, as shown in fig. 2, was put into a cylinder and pressure applied, when the inside diameter decreased ¼ in., its final shape being about as shown in fig. 3. The ring was not cut open before this trial.

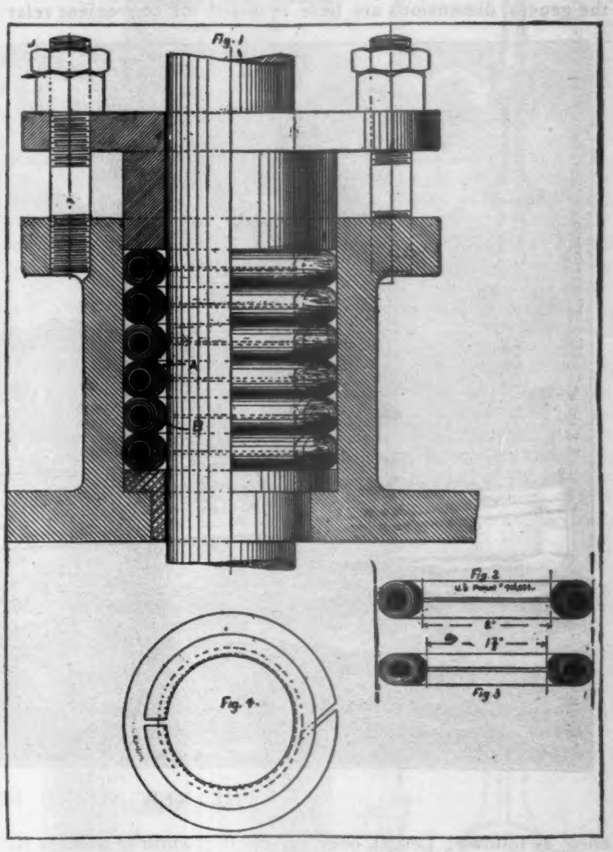
It is claimed that a good metallic packing causes less friction and consequent loss of power than a fibrous packing; for this reason a metallic packing will pay for itself in a short time without considering the further claim that it is easier to take care of and costs less when the time it will last is taken into account.

The packing illustrated has been in continual use for about 10 months, on a high-speed engine of 60 H.-P., and the piston rod is polished like a mirror. The nuts can frequently be tightened up with the fingers alone, without using a wrench, showing the small pressure required on the gland.

This packing is invented by Mr. S. Udstad, of Aurora, Ill., from whom further information in relation to it may be obtained.

Electrical Notes.

THE Electro-Automatic Rapid Transit Company, of Baltimore, on a two-mile experimental track, near Laurel, Md., has, it is stated, recently attained a speed of two miles per minute, with the moter and car. The object of this method of rapid transit is for the transportation of mails and light express matter, between large cities and the automatic control of the speed and stops from a central, or terminal station, without traveling attendants.



THE Westinghouse Electric Company, the Consolidated Electric Company, the United States Electric Company, the Westinghouse Electric Company of England, and various other smaller concerns have been consolidated under one charter, and will be known as the Westinghouse Electric & Manufacturing Company of Pittsburgh. The capital stock of the company is $5,000,000. The consolidated concerns have now 2,000 people employed. They manufacture 8,000 incandescent lamps per day, and they do a business of about $4,000,000 per year. The works in Pittsburgh are being enlarged.

THE East Cleveland Street Railroad recently opened a new extension on Prospect Street and Euclid Avenue, in Cleveland, O. The Company expects to operate 60 cars on this road as soon as the moters can be supplied, when the horses will all be removed from the line. This is an overhead conductor line, with the Sprague motor on the cars.

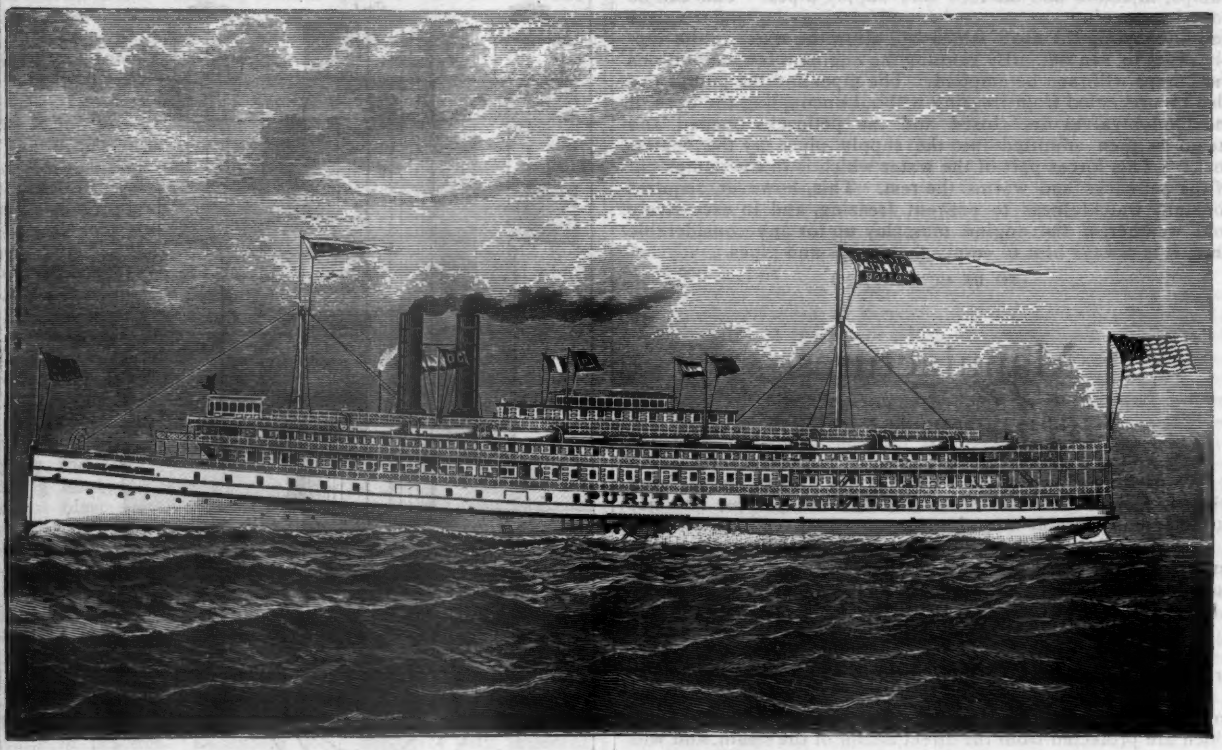
MR. JOSEPH SMITH, Director of the Julien Electric Traction Company, Limited, of England, has just effected an amalgamation of all the storage-battery companies and the chief electric-railway companies of England, under the name of the Electric Construction Corporation, Limited. In this amalgamation are included the following companies: the Julien Electric Company, Limited, of England; the Electric Power Storage Company, Limited, owning the Faure-Sellon-Volckmar patents, as well as being the parent company and licenser of the Electrical Accumulator Company of New York; the Elwell-Parker Company, Limited, being a large storage-battery company of England, and the rival for years of the Electric Power Storage Company, Limited; the Railway Electrical Contractors, Lim-

ited; the Sprague patents for electric traction and transmission of power. The capital stock of this new company consists of £500,000.

The Sound Steamer "Puritan."

THE accompanying illustration represents the new steamboat *Puritan*, owned by the Old Colony Steamboat Company and run on the Fall River Line between New York and Boston. The *Puritan* is the largest boat of the kind in the world, and is completed and finished throughout in the best style, lighted with electric lights, and furnished with all the latest appliances for comfort and safety.

Some description of the boat has already been published, but the general dimensions are here repeated for convenient reference, as follows: Length over all, 420 ft.; width of hull, 52 ft.; extreme breadth over guards, 91 ft.; depth of hull amidships, 21 ft.; displacement, 4,650 tons. The hull is double, of steel, and divided into 59 water-tight compartments.



THE NEW SOUND STEAMBOAT "PURITAN."

The wheels are of steel, 35 ft. in diameter and have buckets 14 ft. long and 5 ft. wide, made of ⅞-in. steel plate. They are feathering wheels and will be run at 24 revolutions per minute.

The *Puritan* has a compound, vertical beam, surface-condensing engine of 7,500 H. P. The high-pressure cylinder is 75 in. in diameter and 9 ft. stroke of piston. The low-pressure cylinder is 110 in. in diameter and 14 ft. stroke of piston. The surface condenser has 15,000 square feet of cooling surface, and weighs 53 tons. Of condenser tubes of brass there are 14½ miles in the *Puritan*. Her working-beam is the largest ever made, being 34 ft. in length from center to center, 17 ft. wide, and weighing 42 tons. When it is considered that the section of beam-strap measures 9¼ by 11¼ in., one may get an idea of the enormous strain and the strength of resistance of this beam. The main center of the beam is 19 in. in diameter in bearing. The shafts are 27 in. in diameter in main bearing, 30 in. in gunwale bearing, and are the largest ever made in this country. They weigh 40 tons each. The cranks weigh 9 tons each. The crank-pin is enormous, the bearing being 19 in. in diameter and 22 in. long. These immense forgings were made by the Cleveland City Forge Co., Cleveland, O.

She has eight steel boilers of the Redfield return tubular type, and the maximum working pressure is 110 lbs. to the square inch. Six of these boilers are 18 ft. 1 in. in width, and 15 ft. 2 in. long; the other two are 10 ft. wide and 14 ft. long. Each of the wide boilers has two shells; the narrow boilers have one each, 7 ft. 8 in. in diameter. The boilers contain 850 square feet of grate surface and 26,000 square feet of heating surface. The products of combustion pass through two superheaters, 8 ft. 10 in. inside diameter and 12 ft. 4 in. outside diameter, by 12 ft. high; thence into two smoke-stacks, the top of each being 101 ft. 1 in. from the keel. The fire-room is 78 by 12½ ft. There is a donkey boiler on the main deck for auxiliary purposes.

There are two centrifugal circulating pumps, each capable of throwing 10,000 gallons per minute. Besides these there are three other large pumps, with a combined capacity of 2,000 gallons per minute. Novel features are the three steam capstans, one forward and one on each quarter, to be used in docking the boat. Each capstan has a double cylinder engine, each cylinder 12 in. in diameter and 14-in. stroke. She has two Sturtevant blowers, furnishing fresh air for the fire-room, each capable of 50,000 ft. per minute. She will burn about 120 tons of coal on the trip from New York to Fall River and back.

The contract for the entire boat was taken by the W. & A. Fletcher Company, and the engine was built by that Company at its North River Iron Works in New York. The hull was built at Chester, Pa., by the Delaware River Ship & Engine Building Company. The joiner work was done by William Rowland, of New York, and the electric light plant was furnished by the Edison United Company.—*Marine Journal.*

Blast Furnaces of the United States.

THE *American Manufacturer's* statement of the condition of the blast furnaces on July 1 is as follows:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	63	11,204	101	13,350
Anthracite	90	31,848	99	25,944
Bituminous	131	89,356	115	54,260
Total	284	132,408	315	93,554

The appended table shows the number of furnaces in blast on July 1, 1889, and on July 1, 1888, with their weekly capacity:

	July 1, 1889.		July 1, 1888.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	63	11,204	68	12,753
Anthracite	90	31,848	96	28,176
Bituminous	131	89,356	119	74,743
Total	284	132,408	273	115,672

This shows an increase of 11 furnaces and of 16,736 tons weekly capacity this year over last year.

The Willans Triple-Expansion Engine.

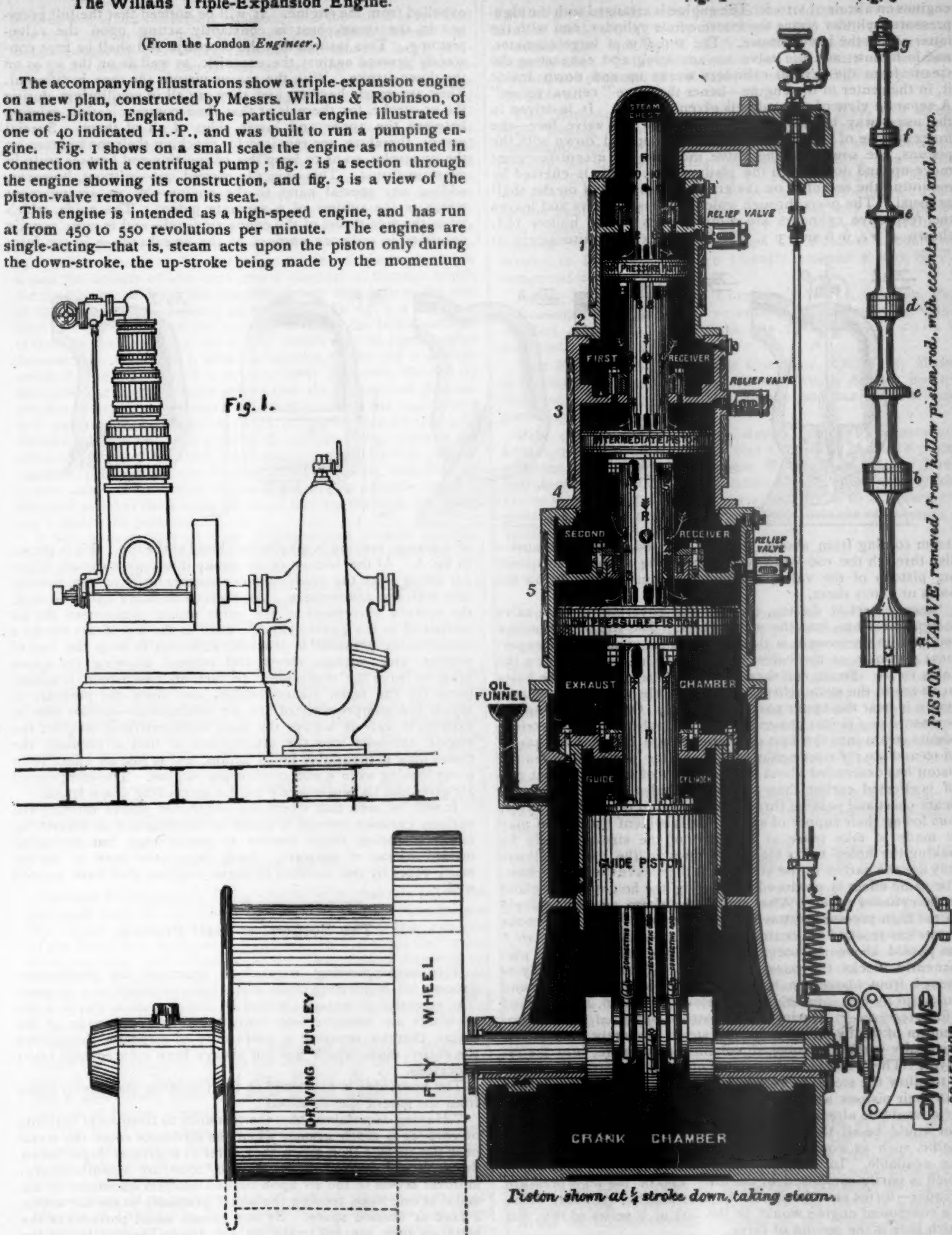
(From the London *Engineer*.)

The accompanying illustrations show a triple-expansion engine on a new plan, constructed by Messrs. Willans & Robinson, of Thames-Ditton, England. The particular engine illustrated is one of 40 indicated H.-P., and was built to run a pumping engine. Fig. 1 shows on a small scale the engine as mounted in connection with a centrifugal pump; fig. 2 is a section through the engine showing its construction, and fig. 3 is a view of the piston-valve removed from its seat.

This engine is intended as a high-speed engine, and has run at from 450 to 550 revolutions per minute. The engines are single-acting—that is, steam acts upon the piston only during the down-stroke, the up-stroke being made by the momentum of the fly-wheel against an air-cushion in the lowest cylinder. The arrangement, it is claimed, renders high speed not only practicable, but also makes a very easy-running and durable engine, small ones of this pattern having been run for over two years with almost unappreciable wear on the bearings and piston-rings.

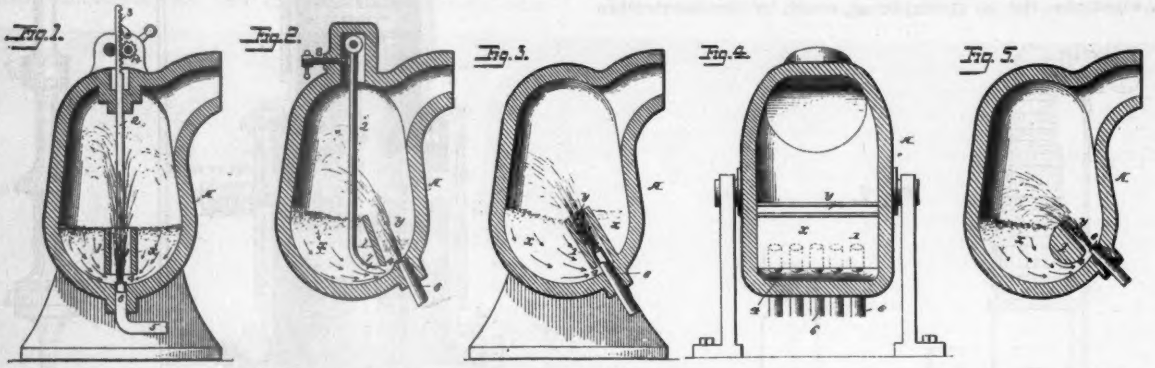
The crank-shaft revolves in a chamber filled to a certain height with lubricant—mixed water and oil—and splashes it in the form of a constant fine spray over the connecting-rods and movable parts; the lubrication is thus automatic, and the main bearings are continuously flooded with oil. In practice it is found that a very small amount of lubricant is sufficient. A full description of the engine is given below.

Fig. 2 gives a section through one of the 40 indicated H.-P.



Piston shown at ½ stroke down, taking steam.

engines on a scale of 1:10.8. The engine is arranged with the high-pressure cylinder above the intermediate cylinder, and with the latter above the low-pressure. The rod *R* is of large diameter, and is hollow, and the valve for admitting and exhausting the steam from the several cylinders works up and down inside it, in the center of the engine—hence the name "central valve." A separate view of the valve is given in fig. 3. It is driven in the usual way by an eccentric, but since the valve face—the inner surface of the hollow rod—moves up and down with the pistons, the source of the valve motion—the eccentric—must move up and down with the pistons also. This is effected by mounting the eccentric on the crank-pin, instead of on the shaft as usual. The ports through which the steam enters and leaves the respective cylinders are simply holes in the hollow rod, shown at *e e*, 6 6 and 3 3. These are exposed alternately to steam coming from above, through the rod, and to exhaust—also through the rod—downward according as the corresponding pistons of the valve, marked *f*, *d*, and *b*, pass below the holes or above them.



Steam enters at the top, through the governor throttle-valve shown in section, into the steam-chest. The top of the hollow rod, though uncovered, is closed against the steam by the uppermost piston, *g*, of the valve, which works in the part above the holes 10 10. Steam can therefore enter the rod when the holes 10 10 are in the steam-chest, as they are when the high-pressure piston is near the upper part of its travel. On commencing the down-stroke *f* is just passing below the holes *e e*, and therefore admits steam into the first or high-pressure cylinder by way of 10 10 and 9 9; *f* rises again, and closes the ports 9 9, when the piston has descended about three-quarters of its stroke; but cut-off is effected earlier than this by the holes 10 10 leaving the steam-chest and passing through the gland in the cylinder cover, thus losing their supply of steam. It is evident that cut-off may be made to take place at any part of the stroke, merely by making the holes 10 10 higher or lower in the rod; the lower they are the earlier in the stroke will they leave the steam-chest. The same effect is produced by altering the height of the gland in the cylinder cover. After cut-off the steam acts expansively on the high-pressure piston in the usual way. By the time the piston has reached the bottom of its stroke, the piston valve *f* has passed above the ports *e e*, and, as the valve *e*, fig. 3, permanently blocks the passage between 8 8 and 7 7, a way is opened from above the high-pressure piston, through *e e* and out again by 8 8, into the space below the piston, and marked "first receiver." During the up-stroke—effected by the momentum of the fly-wheel only—the steam is merely transferred, practically without change of volume or pressure, into the receiver. The "receiver" might be open to the atmosphere, so as to allow the steam to escape at once, the two lower cylinders with their pistons and valves being omitted. In that case the cycle would be already complete, and in fact the above description would be all the description needed for a Willans simple engine, such as would be used where only low-pressure steam was available. In the present case, however, the receiver—which is partly composed of the lower end of the high-pressure cylinder—forms also the steam-chest for another cylinder, which in a compound engine would be the last of a series of two, but which here is the second of three.

At the beginning of the succeeding down-stroke steam passes from the receiver, by the holes 7 7, into the hollow rod again, and out by 6 6 into the intermediate cylinder, until cut-off occurs by the descent of the holes 7 7 through the cylinder cover. On the next stroke the steam exhausts, just as described above, through 6 6 and 5 5 into the second receiver; in the next down-stroke it passes into the low-pressure cylinder, through 4 4 and 3 3; in the next up-stroke it is transferred, through 3 3 and 2 2 into the exhaust chamber, which is in communication with the atmosphere, but it is not until the third revolution after that in which the steam enters the high-pressure cylinder that it is finally expelled from the engine. It will be noticed that the full pressure in the steam-chest is constantly acting upon the valve-piston *g*. This insures that the eccentric rod shall be kept constantly pressed against the eccentric, as well as on the up as on the down-stroke. With the steam pistons the case is different. They are much heavier, and they are all in equilibrium during the up-stroke, for there is at that time communication existing between the upper and lower sides of all of them. Special means, therefore, are required for checking their momentum on the up-stroke, so as to keep the connecting-rod brasses truly in constant thrust. This object is carried out—without, however, adding any special parts to the engine—by an arrangement which is the subject of a separate patent. The guide, which takes the side-thrust of the connecting-rod—and is more usually described in ordinary engines as the crosshead—is in the form of a piston, moving in a cylinder closed at the top; this is shown in fig. 2. At the bottom of its stroke it uncovers certain holes, *l l*, which place the guide-cylinder momentarily in communication with the atmosphere. As there is no other outlet from it, the upward movement of the guide piston compresses the air contained in the guide-cylinder, until at the top of the stroke a considerable pressure is reached, sufficient to stop the line of pistons, etc., without shock, and without allowing the upper brass to leave the crank-pin. In fact, an air-cushion is substituted for the usual steam-cushion, and since the pressure at which the compression of the air commences—unlike that of exhaust steam—is always the same irrespective of whether the engine exhausts into the atmosphere or into a vacuum, the cushioning is invariable in its action, and is just as effective in a condensing as in a non-condensing engine. The compressed air gives out its power again on the succeeding down-stroke.

It will be seen that where the piston-rod passes through the various cylinder covers a gland or stuffing-box is formed by cast-iron spring rings, similar to piston-rings, but springing inward instead of outward. Such rings have been in use for many years by the builders of these engines, and have worked well.

The Bookwalter Steel Process.

THE accompanying engravings illustrate the Bookwalter process for converting crude metal into malleable iron or steel. The essential advantage claimed for this process is that in it the air-blasts are brought into contact with every portion of the metal, thereby securing a uniformity of structure throughout the entire mass which has not always been secured with other processes.

The main idea is expressed in the following statement, taken from the patent specifications:

"Having ascertained that the tendency to form local currents or vortices is much greater when the air-blasts enter the metal near the surface than when they enter at a greater depth below the surface, I devised means whereby to secure a continuously-uniform action of the air upon limited uniform quantities of the metal at one time, feeding the metal gradually to the air within a fixed or limited space. By this means small portions of the metal as they are fed to the air are driven thereby out of the zone of violent agitation of the air and metal, and thereafter are thrown back toward the greater body of metal while a new portion of the latter is being brought under the influence of the air, that portion of the metal which is submitted to the action of the air being the purest portion of the body—that is, having combined with it less scoria than any other portion—and the greater body of the metal which is not under the direct influence of the air being comparatively stationary and free from currents or vortices."

The means devised for securing the desired results consist in dividing the converter into chambers of unequal size. The

smaller one is the converting chamber, and the metal is fed into this at a uniform rate, meeting the air-blast, which forces it outward through the converting chamber and into the larger division above and upon the surface of the large body of molten metal. In this way a circulation of metal is produced until the whole of it has been submitted to the action of the air-blast and converted.

The apparatus may be constructed in different ways, some of which are shown in the engravings. In all these the general outline and form of the converter is that of a vessel supported on trunnions, and very similar in outward shape to the Bessemer converter. In fig. 1 the lower part of the converter is divided into two chambers, by means of a partition 1, of refractory material, and adjustable by a rod 2 extending through the top of the converter and provided with a rack 3 and pinion 14, by which the partition can be raised or lowered, leaving between it and the bottom of the converter a channel 4, through which the molten metal from the chamber x may flow into y, the rate of the flow being regulated as required. In fig. 2 a different form is shown, in which the opening between the two chambers is through the channel 4, the size of which may be increased or decreased by the valve 7, which is moved by the rod 2 and the screw 8. In figs. 3 and 4 the converter is shown divided by means of partition 1 in such a way that the contents of the conversion chamber are thrown diagonally across the converter; this partition may consist of tubes arranged side by side or a diaphragm provided with a series of tuyeres. Fig. 5 shows another construction in which the division is made by a transverse partition projecting above the surface of the metal, and inclined at one side, across which the air-blast at any suitable angle is directed to meet the stream of metal flowing through the channel 4 under the partition.

It will be seen that all these arrangements present substantially the same principle—that is, the two chambers and the circulation of the metal under the air-blast.

This process is covered by patent No. 405,766, dated June 25, 1889; issued to J. W. Bookwalter, of Springfield, O.

A New Typewriter Attachment.

A RUBBER mat, which it is claimed will deaden the noise of a typewriter, produce an easier and more agreeable touch, and save the wear on the machine, is being introduced by the United Rubber Company, Trenton, N. J. This mat is of rectangular form, and is interposed between the machine and the table, forming a cushion, which reduces the noise to the lowest minimum point and furnishes an elastic bed for the machine. The idea is a good one, and the mat itself is of very neat form, and can be applied to any table or typewriter. One of these mats is in use in this office with good results.

Manufacturing Notes.

RIEHLE BROTHERS, of Philadelphia, have recently sold a 60-ton track scale to the Thomas Iron Company, Hokendauqua, Pa. Sales of testing machines include a 20,000-lbs. machine to the Penn Salt Company, Natrona, Pa.; a 5,000-lbs. transverse machine, with indicator, to the Chattanooga Agricultural Works; a 1,000-lbs. cement-testing machine for the State University of Iowa, and a number of smaller machines. This firm recently shipped a weighmaster's frame and standard, made of Turkish standard, to Algeria.

THE Port Henry Iron Ore Company is building a large new trestle for discharging ore, at the terminus of the Lake Champlain & Moriah Railroad, at Port Henry, N. Y. The trestle has a new patent chute and scale houses, fitted with the latest pattern of Fairbanks scales.

THE Pond Engineering Company, St. Louis, report a large number of inquiries for Water Works. They have lately sold to the Belleville water-works an aerator which will purify the entire supply of that city. They are also furnishing a Gaskell non-compound pumping-engine of 750,000 gallons capacity for the city of Taylorville, Ill. Their Omaha office has just closed a contract with the city of Fremont, Neb., for a complete reconstruction of the water-works, with the Holly system, including a Gaskell compound-condensing pumping-engine of 1,500,000 gallons capacity, with boilers and laying of all water-mains, hydrants, valves, etc., throughout the city. They will also furnish a complete system of driven wells, 75 ft. deep, to give a water-supply of 2,000,000 gallons daily. These wells will be put in by the Cook Well Company of St. Louis. The Company will also furnish the Greensburg Water Company, Greensburg, Ind., with two 75 H.P. boilers, with all fittings complete.

THE Chicago Splice-Bar Mill, Morris Sellers & Co., proprietors, have started up with the new 600 H.P. steam-engine and heavier train of rolls. The introduction and use of heavier sections of steel rails by many of our principal railroads has necessitated the making of much larger splice-bars than were formerly used. This they have provided for in their new machinery, and are prepared to roll bars for rails running from 70 to 100 lbs. per yard.

THE Westinghouse Machine Company, in May, sold 82 engines, footing up over 4,500 H. P.; about 2,200 H. P. being compound engines. A large number of engines have been sold recently for electric lighting purposes, including one of 200 H. P. to Elgin, Ill.; two of 65 H. P. to Springfield, Mass.; one of 125 and one of 60 H. P. to Council Bluffs, Ia., and a smaller engine to Hayward, Cal. The Company has supplied two compound engines of 200 H. P. for the electric railroad between Omaha and Council Bluffs. The Baldwin Locomotive Works, in Philadelphia, have recently ordered a 200 H. P., compound engine.

AT the Pennsylvania Steel Company's Works, Steelton, Pa., a Bessemer steel shaft was recently cast successfully, which weighed 45,000 lbs. The mold was 25 ft. long and 29 in. in diameter.

THE Fitchburg Steam Engine Company, Fitchburg, Mass., is furnishing the power plant for the North Adams Electric Railroad, including one single engine and one tandem compound engine.

THE contract for two large duplex gas compressors and boilers, for the Kentucky Rock Gas Company, has been placed with the Clayton Air Compressor Works, New York. These compressors have a capacity of 2,000,000 cubic feet per day, and are to compress the natural gas at the wells to a pressure of 200 lbs. per square inch, and force it a distance of 32 miles to Louisville, for light and power purposes.

Bridges.

THE Berlin Iron Bridge Company, East Berlin, Conn., has just completed 23 spans of iron bridge for the Hartford & Connecticut Western Railroad; these spans are of different lengths and replace old wooden bridges. The Company is erecting an iron bridge, with three spans of 150 ft. each, for the Somerset Railroad, at Carratunk Falls, Me. The Company also has on hand an iron bridge across the Canadian River in Texas; and iron buildings for the Wilcox & Crittenden Company, at Middletown, Conn.; for the Holmes, Booth & Hayden Company at Waterbury, Conn., and for the Shelby Iron Works at Shelby, Ala.

THE Louisville Bridge & Iron Company has a contract for several new spans of iron bridge for the Louisville & Nashville Railroad.

THE Pittsburgh Bridge Company has a contract for a new highway bridge over the Conemaugh River, to have two spans of 160 ft. each.

THE Atlanta Bridge Company, Atlanta, Ga., has the contract for an iron bridge over the Tallapoosa on the Anniston & Montgomery Railroad. This bridge will have a draw span 250 ft. long; two fixed spans of 150 ft. each; one of 100 ft., and one of 75 ft.

THE Milwaukee Bridge & Iron Works has taken the contract for the new bridge over the Illinois River, at Beardstown, Ill. The bridge will have a draw span 300 ft. long and seven fixed spans of 107 ft. each.

Cars.

THE Pennsylvania Company's car shops at Fort Wayne, Ind., are building 100 refrigerator cars for the Pittsburgh, Cincinnati & St. Louis road; 30 having been completed. These cars are of the pattern of which 50 were built some time ago for the Union Line. The form of the car is the same as that of the Pennsylvania export refrigerator car, but there is a difference in the ice compartments. Instead of the closed tanks of galvanized iron, used in the export cars, the ice compartments consist of two iron baskets in each end of the car, lined with galvanized wire netting, and separated from the body of the car by partitions or bulkheads, with an open space above and below, giving a free circulation of air over the ice. These cars are equipped with the Graham draft-rigging, air-brakes, and Janney couplers.

THE Missouri Car & Foundry Company, St. Louis, Mo., is building 300 fruit cars for the Louisville & Nashville Railroad.

THE Ohio Falls Car Works, Jeffersonville, Ind., has a contract for 200 fruit cars for the Louisville & Nashville Railroad.

THE Industrial Works at Bay City, Mich., have completed a large iron transfer crane of 15 tons capacity for the Chicago, Rock Island & Pacific Railroad, and are building for the same road several boiler cranes for station use.

Marine Engineering.

THE new side-wheel steamer *Kennebec* has recently been put in service between Boston and ports on the Kennebec River. This vessel was built at Bath, Me.; is 265 ft. long; 37 ft. beam; 62 ft. over the guards, and 13 ft. depth of hold. She is handsomely fitted up with abundant accommodation for passengers. The engine was built by the Morgan Iron Works, New York; it is a beam engine, with cylinder 60 in. in diameter and 11 ft. stroke; the wheels are 33 ft. diameter and 8 ft. face.

THE Harlan & Hollingsworth Company, Wilmington, Del., is building for the New York, New Haven & Hartford Company a transfer boat to take the place of the old *Maryland*, between Jersey City and Harlem. The boat is 250 ft. over all, and 66 ft. width of deck; she will have two independent, horizontal compound engines, with cylinders 24 in. and 44 in. in diameter and 9 ft. stroke, placed one on each guard and furnished with steam by four steel boilers in the hold.

THE Continental Iron Works, Brooklyn, N. Y., have just shipped to Hammond & Coon's Lake Erie Boiler Works, Buffalo, N. Y., 16 of their corrugated boiler furnaces, to be used in the boilers of the new *Old Colony* steamer, for which this firm holds the contract.

THE Harlan & Hollingsworth Company have recently completed a new steel passenger steamboat for the New Jersey Central Railroad, to run between New York and Sandy Hook, in company with the *Monmouth*, built last year. The *Sandy Hook* is 230 ft. long; 37 ft. beam; 49 ft. wide, over the guards; 15 ft. 6 in. depth of hold, and draws about $10\frac{1}{2}$ ft. of water. The boat is propelled by twin screws, each driven by an independent triple-expansion engine, with cylinders 22, 36, and 55 in. diameter and 28 in. stroke. Steam is furnished by four Scotch boilers, made to carry a working pressure of 160 lbs. The passenger accommodations are very handsome, and the boat is provided with electric lights and all the latest improvements.

OBITUARY.

DANA C. BARBER died July 1, at Knowles, Md. Mr. Barber was a most careful and painstaking engineer, and was associated with Rudolph Hering in the very extensive surveys made by that gentleman for an improved water-supply for the city of Philadelphia. His last work was the preparation of an Index of articles pertaining to sewerage and sewage disposal. He was for some time connected with the *Engineering and Building Record*.

CHIEF-ENGINEER WILLIAM H. HUNT, U.S.N., retired, died at his residence in Washington, D. C., Tuesday, June 25, 1889. After a thorough course of scientific preparation he entered the Navy as third assistant-engineer. He was a gallant and accomplished officer, his service extending through the entire period of the War of the Rebellion, serving with great credit and efficiency in the fleet of Admiral Farragut. Many personal deeds of daring and bravery in his chosen profession attest the value of his services to the Government. Mr. Hunt leaves a widow and three sons.

JAMES BEGGS, a well-known mechanical engineer, shot and killed himself in Trenton, N. J., July 19, while on a visit to that city. He was 50 years old, was born in Paterson, N. J., and was a resident of that city. He had been Master Mechanic of the Delaware, Lackawanna & Western shops in Scranton, Pa., and Superintendent of Crane Brothers' works in Chicago. For some years past he has been head of the firm of James Beggs & Company, manufacturers of machinery and supplies, having offices in New York and works at Erie, Pa. No cause for Mr. Beggs's suicide is known, and it is believed that he was temporarily insane.

PERSONALS.

M. M. MARTIN is Superintendent of Car Department of the Wabash Western Railroad, with office at Decatur, Ill.

WALTER ANCKER has been appointed Acting Supervisor of Steamboats of the Baltimore & Ohio Railroad.

GEORGE A. QUINLAN is now Chief Engineer and General Superintendent of the Houston & Texas Central Railroad.

HORACE A. TAYLOR, of Wisconsin, has been appointed Commissioner of Railroads in the Interior Department at Washington.

C. C. WAITE has resigned his position as Vice-President and General Manager of the Cincinnati, Hamilton & Dayton Railroad.

E. T. TURNER, C.E., has been appointed Director of the New York State Meteorological Bureau and Weather Station at Ithaca.

REID T. STEWART has been appointed Adjunct Professor of Mathematics and Engineering in the Western University of Pennsylvania.

J. B. BARNES is now Superintendent of Motive Power and Machinery of the Wabash Western Railroad, with office at Springfield, Ill.

HENRY C. MEYER, Editor of the *Engineering and Building Record*, sailed from New York for Europe, July 6, for a month's vacation.

GEORGE W. PRESCOTT is Superintendent of Machinery and Car Department of the California Southern and California Central Railroads.

THOMAS RODD, formerly Principal Assistant Engineer of the Pennsylvania lines west of Pittsburgh, has been appointed Chief Engineer, to succeed Mr. F. Slataper.

F. M. THORN has resigned his position as Superintendent of the United States Coast Survey, after a term in which he has filled the office very successfully.

H. R. WHEELER is now Engineer in Charge of the Zigzag Tunnel improvement on the New York, Ontario & Western Road, and has his headquarters at Walton, N. Y.

W. S. MORRIS, recently on the Wabash, has been appointed Superintendent of Motive Power of the Detroit, Lansing & Northern and Chicago & West Michigan Railroads.

COLONEL H. T. DOUGLAS has been appointed Chief Engineer of the Baltimore & Ohio Railroad. He has been for some time Chief Engineer of the Philadelphia Line.

WILLIAM WILSON, for a number of years past Superintendent of Machinery of the Chicago & Alton Railroad, has resigned that position on account of his health.

GEORGE S. MORISON, C.E., has removed his Chicago office from 205 La Salle Street to The Rookery, Room 1120. His New York office remains at 35 Wall Street, as heretofore.

F. W. D. HOLBROOK, late Principal Assistant Engineer, has been appointed Manager of the Seattle, Lake Shore & Eastern Railroad, with office at Seattle, Washington.

J. HERBERT SHEDD, of Providence, R. I., is Consulting Engineer, and WILLIAM M. BROWN is Chief and Resident Engineer of the new water-works at Wellington, Kan.

P. LEEDS has been appointed Superintendent of Machinery of the Louisville & Nashville Railroad. He was recently Master Mechanic in charge of the Louisville shops of that road.

ANDREW ONDERDONK, recently on the Baltimore & Ohio, is now Chief Engineer of the Roanoke & Southern Railroad, with office at Winston, N. C.

GEORGE HACKNEY has resigned his position as Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad, after a long term of service on the road.

COLONEL WILLIAM E. MERRILL, U. S. Engineers, has gone to Paris as the American representative to the Congress of Waterway Engineers to be held in connection with the Exposition.

A. W. QUACKENBUSH has been appointed Superintendent of Machinery of the Chicago & Alton Railroad, with office at Bloomington, Ill. He was recently General Master Mechanic of the Wabash Western.

F. SLATAPER, who has been in the service of the Pennsylvania Company continuously for over 25 years as Chief Engineer, has been appointed Consulting Engineer, having decided to retire from active work.

GAVIN CAMPBELL has been appointed General Superintendent of the Wisconsin Central Railroad. He was formerly Master Mechanic of that road, but for several years past has been General Manager of the Green Bay, Winona & St. Paul.

COLONEL JOHN G. PARKE, U. S. Engineers, has been placed on the retired list of the Army at his own request, after 40 years of service. For some time past he has been at the head of the Military Academy at West Point.

HARVEY MIDDLETON has been appointed Superintendent of Machinery of the Atchison, Topeka & Santa Fé Railroad in place of George Hackney, resigned. Mr. Middleton has been for some time Superintendent of Machinery of the Louisville & Nashville Railroad.

COLONEL JOHN N. WILSON, U. S. Engineers, has been relieved from duty in charge of the Washington Aqueduct extension. He retains charge of the Washington Monument, and is still Commissioner of Public Buildings and Grounds. He is succeeded in charge of the Washington Aqueduct by LIEUTENANT-COLONEL GEORGE H. ELLIOT.

DR. THOMAS C. MENDENHALL, of Indiana, has been appointed Superintendent of the United States Coast and Geodetic Survey. He is now President of the Rose Polytechnic Institute at Terre Haute, Ind., and has served as Professor in the Ohio University and in the Imperial University of Japan; he was also for some time connected with the United States Signal Service.

PROCEEDINGS OF SOCIETIES.

Master Car-Builders' Association.—The Twenty-third Annual Convention began at Saratoga Springs, N. Y., June 25. The presidential address was delivered by Mr. McWood, and short speeches were made by the Chairman of the New York Railroad Commission and by Mr. Coffin, of Iowa.

The Secretary's report showed a total of 140 Active; 93 Representative, and 5 Associate members. The number of cars represented is about 800,000. A balance of $190 cash is on hand.

After the appointment of the usual committees an adjournment was had until afternoon.

At the afternoon session the Committee on the Interchange of Passenger Cars reported that there was no immediate demand for a code of rules for passenger cars and recommended that the matter be dropped. This was followed by a long discussion and finally the report was approved, but it was resolved to include the question of Standard Height of Draw-bars for Passenger Cars in the subjects for discussion.

The reports of the Committees on the Standard Journal-Box Lid and on Journal Lubrication were read and discussed.

On the second day the Nominating Committee presented its report; the rest of the session was devoted to the discussion of the Rules of Interchange, according to the provisions of the Constitution. No other business was done on that day except to listen to an address from Mr. Coffin, and to a report from the Committee to amend the by-laws in relation to the place of meeting.

On the third day the Rules of Interchange, as amended at the previous session, were approved and adopted as a whole.

The report of the Committee on Car Heating and Ventilation was read and discussed. It was a very elaborate one, giving statements of the experience had with all the different systems of heating which have been actually in use.

The Committee on Specifications for Cast-Iron Wheels submitted a form of contract to be made with wheel-makers, giving also the reasons for the form adopted. The mileage basis for settlement by the Committee is as follows:

36-in. passenger wheels	70,000 miles.
33-in. passenger wheels	60,000 "
36-in. engine and tender wheels	60,000 "
33-in. engine and tender wheels	50,000 "
30-in. engine and tender wheels	45,000 "
28 and 26-in. engine and tender wheels	40,000 "
Refrigerator, through line and cattle cars	24 months.
All other freight cars	48 "

The report was received and the amended contract ordered submitted to letter ballot.

The report of the Committee on Standard Axles for 60,000 lbs. Cars was read, and its recommendation was also ordered to be submitted to letter ballot.

The Committee on Standard Brake Gear for Air-Brake Cars and Brake Shoes for Iron Beams presented a long and elaborate report, which was received, and the standard recommended was ordered submitted to letter ballot. These standards were as follows:

1. That the maximum train-pipe pressure be 70 lbs.
2. That the brake power exerted on all freight cars be 70 per cent. of their light weight.
3. That the arrangement of the brake gear for the four conditions named be as shown on sheet 3.
4. That the details as shown on sheet No. 2 be adopted, with all levers 1 in. in thickness. All pins be turned to $1\frac{1}{8}$ in. in diameter, with $\frac{1}{64}$ in. loss. All jaws or clevises to be $\frac{3}{4} \times 2\frac{1}{4}$ in. iron. All rods to be $\frac{3}{4}$ in. in diameter, and all other details as recommended.
5. That the position of train-pipe cock and dummy coupling be as shown on sheet No. 1.
6. That the brake beams for all present forms of freight cars be required to stand a stress of 7,500 lbs., with a maximum deflection of $\frac{1}{16}$ in.; and where it is necessary to use a stronger beam that they stand a stress of 15,000 lbs., with a maximum deflection of $\frac{1}{16}$ in. Where the Westinghouse beam is employed, that the plan shown on sheet No. 4 be standard.
7. That where independent brakes and rubbers are used, that the present standard Christy or Collin rubber be maintained.

The Committee on Buffers and Carrier Irons for the Master Car-Builders' type of coupler was read, and its recommendations were also ordered to be submitted to letter ballot.

The Committee on Subjects suggested the following subjects for discussion at the next Convention, in additionto those carried over, and their report was adopted:

1. A standard and axle box for both 40 and 60,000-lbs. cars and new standard lid.
2. Best metal for brake shoes.
3. Ventilation for steam-heated cars.
4. A system of joint car inspection.
5. Car seats.
6. The substitution of steel plates and malleable iron for cast iron in car construction with a view to reduction of weight.
7. Lighting passenger-train cars.

For the place of next annual meeting several cities were suggested, including Charleston, Chattanooga, and Buffalo. A ballot was taken, but afterward by vote of the Association the by-law was suspended and Charleston, S. C., was designated as the place for holding the Twenty-Fourth Annual Convention.

The following officers were elected for the ensuing year: President, William McWood; Vice-Pesidents, Charles A. Schroyer, E. W. Grieves, J. S. Lentz; Treasurer, John Kirby; Executive Committee, R. C. Blackall, E. Chamberlain, F. D. Casanave.

After the adjournment of the Convention the Executive Committee re-elected Mr. J. W. Cloud, Secretary.

After passing the usual resolutions the Convention adjourned.

American Society of Civil Engineers.—The Twenty-first Annual Convention met at Seabright, N. J., June 20. Mr. J. J. R. Coes was chosen Chairman of the Convention.

On the following day three sessions were held. At the morning session, Theodore Cooper presented a paper on American Railroad Bridges, which was briefly discussed. The Secretary read a discussion by C. Palmer on the forthcoming paper on Timber Trestle Bridges for Railroads, by Onward Bates, and H. B. Seaman presented a paper on Componential Trusses for Traveling Cranes.

At the afternoon session a paper was presented on Lime Sulphite Fiber Manufacture in the United States, by O. E. Michaelis, with some remarks on the chemistry of the process, by Martin L. Griffin. The Secretary read a paper on the Sibley Bridge, by O. Chanute and W. H. Breithaupt, and J. E. Watkins presented a paper on Development of the American Rail and Track.

The evening session was taken up by the address of the President, Max J. Becker, on Engineering Progress During the Past Year.

On June 22 the morning session was occupied by discussion of George W. Raffner's paper on Fresh Water Algæ and Their Relation to the Purity of Public Water-Supply. At the afternoon session the special Committee appointed to investigate the Cause of the Failure of the Conemaugh Dam presented their report, which was a preliminary one. This was discussed at considerable length. After the discussion a short paper by Desmond FitzGerald, on the Maximum Rain-Fall in Boston, was read.

On June 24 the report of the Committee on the Relation of Railroad Wheels and Rails was received and the Committee discharged.

Resolutions providing for a Committee to recommend Uniform Methods of Testing Material and for a Committee to re-

vise the Constitution and By-laws were referred to the Board of Directors, and a resolution providing for a Committee to Obtain Information on Impurity in Water Supplies took the same course. Resolutions were passed recommending the attention of members to the section of the National Museum devoted to Engineering Progress. A telegram of thanks for the cordial reception given to members of the Society, was sent to the English Institution of Civil Engineers.

The evening was devoted to the annual banquet of the Association.

On June 25, at the morning session, Mr. J. B. Francis discussed the effect of a Rapidly Increasing Stream of Water on the Flow below the Point of Supply, with special reference to the Johnstown disaster. A paper on Wheels and Rails, by Mr. D. J. Whittemore, and one on the Effect of Punching on Angle-Plates, by Percival Roberts, Jr., were read.

At the afternoon session a number of papers were read, and two of them on Highway Improvements, by O. H. Landreth, and on Metal Ties, by E. E. R. Tratman, were discussed.

At the afternoon session a paper on the Railroads of Mexico, by W. B. Parsons, Jr., and one on Ship Canals, by R. E. Peary, were read. The usual votes of thanks, etc., were passed, and the Convention adjourned.

A REGULAR meeting was held in New York, July 3. The Tellers announced the following elections:

Members: Waldo Emerson Buck, Lake Village, N H.; William Howard Courtenay, Montgomery, Ala.; Rob Benjamin Davis, Pencoyd, Pa.; Louis Hyde Evans, Chicago, Ill.; Joachim Godtske Giaver, Pittsburgh, Pa.; Edward Gillette, Jr., Plattsmouth, Neb.; William Rufus Northway, Chicago, Ill.; Samuel Harrison Smith, San Francisco, Cal.; Benjamin Thompson, Chattanooga, Tenn.; Paul Sourin King, New York.

Associates: Julius I. Livingston, Bound Brook, N. J.; Thomas Spencer Miller, New York.

Juniors: Norman Smith Latham, Brooklyn, N. Y.; Ludwig Paul Wolfel, Pencoyd, Pa.

Roadmasters' Association of America.—The seventh annual meeting will be held in Denver, Col., September 10, and will continue for three days.

The Committee appointed to prepare a programme of questions for discussion at this meeting have submitted the following:

1. Standard Track-Joints—R. Caffrey, Chairman.
2. Standard Frogs—P. Nolan, Chairman.
3. Labor on Track—O. F. Jordan, Chairman.
4. Automatic Switch-Stands and Protection of Facing Points —Robert Black, Chairman.
5. Track Tools and Implements—S. L. Swinney, Chairman.
6. Standard Cattle-Guards—J. Doyle, Chairman.

Denver Society of Civil Engineers.—At the regular meeting, June 11, A. J. Fonda was elected Second Vice-President and W. W. Follett, Treasurer.

The greater part of the evening was devoted to a discussion of the paving question—a live subject in Denver at present. It was the opinion of the members present that the hardest Colorado sandstone was the proper material with which to pave streets with heavy traffic, but that the streets of lighter travel ought to be paved with Trinidad asphalt.

AT the regular meeting, July 9, Thomas Withers was elected a member. A committee was appointed to prepare and arrange a collection of specimens of sandstone, presented by the Capitol Commission.

Mr. Edmund T. Martin described the Fourteenth Street Viaduct in Denver, which will extend along the south bank of Cherry Creek and across the Platte River to North Denver, having a total length of 3,500 ft. It will cross most of the railroads entering the city, and will have a roadway 40 ft. wide, and two 8-ft. sidewalks. It will be built of iron and earth embankment, and will cost when complete $107,000. The earth embankment along the bank of Cherry Creek will be supported by a wall of slag 8 ft. in height.

The subject of dams being under discussion, Mr. E. S. Nettleton gave a description of the proposed dam across the Rio Grande at El Paso, which is to be built jointly by the United States and Mexico. There are three proposed sites for this dam. It will be 60 ft. high and from 450 to 700 ft. long, according to the site chosen. The reservoir or lake formed will be $3\frac{1}{2}$ miles wide and 15 miles in length. The water will be stored up to be used for manufacturing and irrigating purposes, and the flow controlled by gates.

Car Accountants' Association.—The Fourteenth Annual Convention was held at Mackinac Island, Mich., June 25 and 26, seventy-three roads being represented. After the address of President A. P. Wilder the first order of business was the election of officers, which resulted as follows: President, E. C. Spalding, Western & Atlantic; Vice-President, E. M. Horton, Illinois Central; Treasurer, H. G. Sleight, Terre Haute & Indianapolis; Secretary, H. H. Lyon (re-elected).

The reports of the committees on the following subjects were then submitted: Distribution of Cars; Carding Foreign Cars; Cypher Code; Per Diem Charges; Demurrage; Junction Card Reports; Diversion of Freight Cars.

The report of the Committee on Per Diem Charges indorsed the mixed system on the basis of $\frac{1}{2}$ cent per mile and 10 cents per day. In a lengthy discussion which ensued it was shown that a large number of the roads represented at the meeting favored the straight per diem system, and it was decided by vote to lay the report of the Committee on the table until the next annual meeting, pending the action of the General Time Convention on the question.

There were also interesting discussions of the questions of Demurrage and Diversion of Cars. The following resolution was adopted:

"That it is the sense of this Convention that we have a standard penalty for diversion of cars, and that we make that recommendation to the General Time Convention and leave the matter of penalty to that convention."

It was decided to hold the next annual meeting in New York in May or June, 1890, the exact date to be fixed by the Committee of Arrangements.

Civil Engineers' Club of Cleveland.—At the regular meeting, July 9, the subject for the evening was Architecture. F. S. Barnum opened the discussion with a paper on Domestic Architecture—A Comparative View, contrasting the elegance and convenience of 40 years ago with that of the present day. Ludwig Herman told of a famous bath near Prague, called "Queen Lebusa's bath," which is all that remains of a palace that stood there in the third century. The club voted to have a picnic on August 13, the date of the next regular monthly meeting, when the subject will be Railroad Engineering.

NOTES AND NEWS.

Fast Trains.—On the Atlantic City Division of the Philadelphia & Reading Railroad a run from Camden to Atlantic City, 59 miles, was recently made in 59 minutes and 40 seconds. The train consisted of seven heavily loaded passenger cars and was drawn by one of 10 new engines recently built for this special service.

On the Pittsburgh, Fort Wayne & Chicago Railroad on May 19 last, the Limited Express made the run from Fort Wayne to Chicago Station, 148.3 miles, in 2 hours and 59 minutes, or an average speed of 49.7 miles an hour. The delays from reduced speed and stops amounted to 21 minutes, making the actual running time 158 minutes and the average speed 56.3 miles per hour. The fastest long-distance run was 57.1 miles in 60 minutes; the fastest medium run was 29.2 miles in 27 minutes; the fastest short run 6.3 miles in 5 minutes 20 seconds, or at the rate of 71 miles per hour. In this run the maximum ascending grades encountered were one of 26 ft. to the mile, 4.2 miles long; one of 24 ft. to the mile, 4.3 miles long; and one of 18 ft. to the mile, 3.2 miles long. The number of curves on the line is 23; the maximum curvature 5°, the average curvature 2°.

The train consisted of one combination, one dining and three sleeping-cars, or five cars in all, its total weight being 438,500 lbs. The train was drawn by engine No. 200, which has 18 $\times$ 24-in. cylinders, a boiler 54 in. in diameter, four 62-in. drivers and weighs in all 91,900 lbs. The tender tank has a capacity of 3,600 gals., and the longest distance run for water was 84.2 miles.

The San Diego Flume.—This important work, which has been built by the San Diego & Coronado Water Company, is intended to carry water to the city of San Diego, Cal., and also to supply water for the irrigation of several large tracts of land. The water-shed is in the Cujamaca Mountains, and the Company has constructed a reservoir at a point about 5,000 ft. above sea-level by building a dam 35 ft. and 720 ft. long. The capacity of the reservoir is about 3,740,000,000 gallons. The flume, through which the water is carried, is about 36 miles long, following generally the course of the San Diego River and the Cajon Valley to a reservoir situated on the table-land back of San Diego, at a point 630 ft. above the sea, whence water will be taken into the city in pipes. The main flume is 6 ft. wide and 4 ft. high, built of red-wood plank 2 in. thick,

and is strongly constructed and braced; where possible it rests on rock foundation, but in many places it has been carried over valleys and depressions on wooden trestles and at other points it has been necessary to build tunnels. In addition to the city reservoir several others have been made from which water is distributed for irrigating purposes, and the Company expects to furnish irrigation for about 100,000 acres of land.

Some of the longest trestles are: The Sweetwater Pass, 1,264 ft. long and 81 ft. high; Sweetwater Pass No. 2, 720 ft. long and 25 ft. high; Sycamore Creek, 720 ft. long and 35 ft. high; Connor Creek, 688 ft. long and 34 ft. high; Knob Creek, 600 ft. long and 55 ft. high; Cut-off, 640 ft. long and 48 ft. high; Los Coches, 1,664 ft. long and 70 ft. high; Sand Creek, 600 ft. long and 58 ft. high; South Fork, 420 ft. long and 86 ft. high; Quail Canyon, 560 ft. long and 68 ft. high; Monte, 438 ft. long and 60 ft. high; Chocolate, 450 ft. long and 63 ft. high; there are over 300 smaller ones.

The most important tunnels are: Lankersheim, 1,900 ft. in length; Los Coches, 313 ft.; El Monte, 290 ft.; Cape Horn, 700 ft.; South Fork, 200 ft.; Anderton, 270 ft.; and Sand Creek, 430 ft. These are through solid rock of granite or slate, 6 ft. square, cemented and arched overhead, supports being placed wherever the rock is soft or has any indications of falling.

This is the most important work of the kind on the Pacific coast. It has just been completed, and will soon be in full use.

Shipbuilding in Japan.—On March 12 there was launched at the Imperial dockyard at Yokosuka a new despatch boat named the *Yayeyama Kan*, which is 312 ft. long, 34 ft. wide, has a main draft of 15 ft. and a displacement of 1,600 tons. The ship is intended for speed, and is expected to run up to 20 knots an hour. She will be armed with three 12-cm. guns and some smaller machine-guns and two torpedo tubes. The ship is of steel throughout and has been built, with the boilers, entirely in Japan, but the engines are of English construction, being furnished by Leslie & Company, of Newcastle. They are triple-expansion engines, with cylinders of 31 in., 46 in., and 68-in. diameter and 28-in. stroke, each working a separate screw. The working pressure carried will be 150 lbs., and steam will be furnished by six boilers.

Compound Locomotives in England.—The Northeastern Railway Company is now building at its Gateshead Shops, five compound passenger locomotives of exceptional power and size. These engines are on the Worsdell & Von Borries system, of which the Company already has a number in use. The new engines have a forward truck, one pair of drivers 7 ft. 6 in. in diameter and one pair of trailing wheels. The high-pressure cylinder is 20 in., and the low-pressure 28 in. in diameter, both being 24-in. stroke. They are intended to run the Company's fast express trains.

Baltimore & Ohio Relief Department.—The balance sheet for May shows the payment of benefits by the Relief Department of the Baltimore & Ohio Railroad as follows:

	Number.	Amount.
Accidental death	4	$4,500
Accidental injuries	247	3,551
Natural deaths	18	6,151
Natural sickness	290	4,452
Surgical expenses	151	879
Total	710	$19,533

The Relief Department of the Baltimore & Ohio Railroad is the successor, under the new arrangement, to the old Baltimore & Ohio Employés' Relief Association.

Nails from Tin Scrap.—In a recent paper before the Institute of Mining Engineers, Mr. Oberlin Smith describes a method of making nails from tin scrap, now usually considered as waste. After describing some preliminary experiments, he says: "Our second machine, instead of working upon the principle of regular corrugations, simply crushed up the blanks edgewise into any form they chose to assume.

"The machine now under construction has been very much simplified, and made enormously strong and heavy. It is adapted to cutting, crushing, griping, and heading the nails at one operation, and can be run as fast as an expert operator can feed the material. Its feed probably varies, with jagged, irregular scrap, from 30 to 90 nails per minute, although straight strips of sheet-metal can easily be fed by hand into a machine running as high as 240 strokes per minute.

"During the course of our experiments, various forms of nails have been tried. Among others were straight cylindrical nails with conical points; straight, square nails with pyramidal and with wedge-shaped points; hexagonal nails, etc. The most practical form, however, seems to be a square taper nail, which has about the same shape as the ordinary cut nail, but is somewhat stronger and a good deal tougher. It is well adapted for all ordinary purposes, but is especially suitable for a roofing nail, since the tin coating prevents much rusting, and is good to solder to.

"Among other processes, we have tried winding the nail blank upon itself, after the manner of a window-shade, but minus a mandrel. This, however, was difficult in execution, and was not found available in practice.

"The economy of this system of nail-making is obvious. The scrap can be bought for about 17 cents per 100 lbs., and a boy can make perhaps 100 lbs. of nails per day."

Railroads in Algeria.—In the year 1879 the general plans for the construction of the railroads of Algeria were drawn up, and these plans having been rigidly adhered to, the various lines are rapidly approaching completion. The plans referred to are based upon, first, the commercial interests of the country; second, the defense of the territory against enemies, either foreign or domestic.

The total length of completed railroads in Algeria is 1,683 miles, and can be divided into two great sections.

1. That section which includes the lines running parallel to the seashore, and extending from the frontier of Morocco to the boundary of Tunis, and connecting all the seaports of Algeria.

2. This section includes all the lines running from the sea-coast to the interior, which may be more properly termed "lines of penetration." In the case of insurrection these lines would be of very great importance and utility in moving troops with despatch. From a commercial point of view, the whole of these lines are of vital importance, and will assuredly contribute much to the rapid development of the colony. Prior to the building of these lines the means of transportation were of the most primitive description, whereas now the facilities afforded and low rates granted permit of the products of the interior being carried to the seaboard, where ready markets are always to be found.

The railroads are under the control of six companies: The Paris, Lyons & Mediterranean Company; the East Algerian Company; the Bone-Guelma Company; the West Algerian Company; the Franco-Algerian Company, and the Moktabel-Hadid Company.

Two new lines are under construction, from Oued-Rhamour to Ain-Beida and from Blidah to Berroughia, and other lines of less importance are being surveyed. One of these is to extend to the Tunisian frontier, and another to the iron mines of Rio Salado.

Variations in Thickness of Large-Rolled Plates.—Constructors in different countries now demand from the forges and rolling-mills plates of iron and steel of very large size, and the rolling of these plates of even thickness presents considerable difficulties. It has been thought important to make some tests of this matter, and three German manufacturers—Krupp at Essen, Schultz-Knaudt at the same place, and Grillo, Funke & Company at Schalke—have made recently a series of experiments. This was done by taking a large number of micrometric measurements of large plates in such a way as to determine their maximum and minimum thickness, and then comparing these with the average thickness, which was obtained by calculation from the weight of the plates, assuming a density of 7.76.

The results obtained from three specimen plates in this way were as follows, reduced to inches:

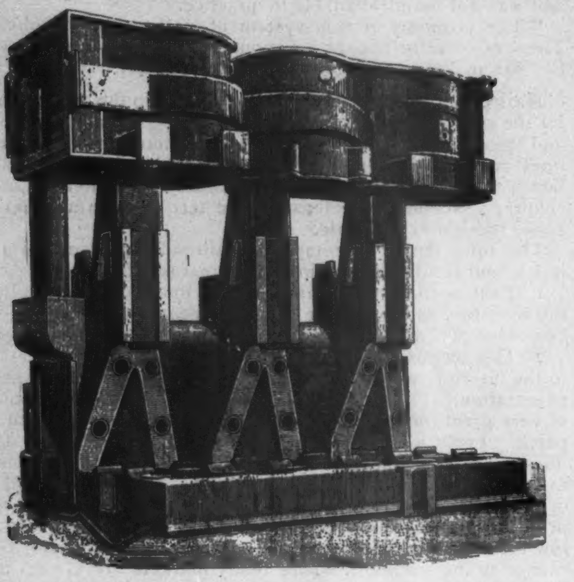
Maker.	Size of Plate.	Thickness of Plate.		
		Minimum.	Maximum.	Calculated.
1. Schultz-Knaudt... ...	118 × 151 in.	0.4772 in.	0.5728 in.	0.5575 in.
2. Grillo, Funke & Co....	86 × 100 "	0.7146 "	0.7563 "	0.7394 "
3. Krupp	110 × 141 "	0.5118 "	0.6220 "	0.5972 "

In No. 1, the largest and thinnest plate, the total variation was 0.0956 in, the minimum measurement being 14.2 per cent. below, and the maximum 2.7 per cent. above the calculated thickness. In No. 2, the heaviest plate, the total variation was 0.0417 in., with the minimum 3.4 per cent. below, and the maximum 2.3 per cent. above the calculated thickness; this plate showed the least variation. No. 3 showed the greatest variation, the total difference being 0.1102 in., the maximum being 4.2 per cent. above, and the minimum 14.3 per cent. below the calculated thickness.

It will be readily understood that if such irregularities are found in specimen plates they may be still greater in those made in ordinary work, without special care, and the resulting in-

conveniences can at once be seen. There is, therefore, a serious reason for not exceeding the dimensions already reached for rolled plates, especially in making boilers, at least until new improvements are made in rolling.—*Le Genie Civil.*

A Remarkable Casting.—The accompanying illustration, from the London *Engineer*, shows a remarkable casting, which is exhibited in the Paris Exposition by the John Cockerill Company, of Seraing, Belgium. This casting is shown in its untrim-



med condition and weighs about 24,000 lbs.; it consists of the frame, cylinders, crosshead-guides, shaft-blocks, condenser, air and feed pumps of a triple-expansion engine, all contained in a single casting. It is probably more intricate in detail than any one casting ever made, and is certainly a very remarkable piece of work. It is not meant to serve any purpose, and is not likely to be repeated; the intention being merely to show what can be accomplished by the pattern-maker and molder. This casting was designed by M. Resimond, head of the foundry department at Seraing, and was executed under his direction.

A London Rapid-Transit Project.—London, like New York, is agitating new schemes for rapid transit. The latest one proposed is, in some of its features, like the Arcade plan, which at one time seemed likely to be carried out in New York. It is described in a recent number of the *Railway Press*.

The idea is to excavate the full width of the street to a depth of 14 or 15 ft., and to put at the bottom of this excavation a stratum of concrete about 2 ft. thick. A strong wall is to be built at each side about on a line with the edge of the sidewalk, and upon these walls will rest steel girders, which will carry a floor of steel plates protected by asphalt, which will carry the usual street pavement. The excavation will give room for four parallel tracks, while at each side, and outside of the railroad proper, will be a gallery in which can be placed the water-pipes, gas-pipes, conduits for electric wires, etc. It is proposed to use two of the tracks for way trains making frequent stops, and the other two for express trains stopping at longer intervals, or only at the more important stations.

The motive power of the proposed line is electricity, so that there will be no trouble with smoke or steam, while the small depth of the road below the surface will make ventilation and lighting comparatively easy. The power will be provided from stations placed wherever it may be found most convenient, as it can be readily conducted to the line where it is wanted.

Divisions are to be made between the separate tunnels of the subway by panels of a new material known as ferflax, which is a tough substance formed by compressing vegetable fiber upon a foundation of steel netting. These panels will be supported by pillars placed at proper intervals and connected above with the floor girders.

Elevated railroads are not considered admissible in London, while the present underground roads, although largely used, are not favorably regarded by the public, owing to their poor ventilation, darkness, and the long flights of stairs required to reach them from the street, on account of their depth below the surface. Additional facilities are needed, however, and this plan is proposed to meet the exigencies of the case.

Torpedo-Boats in Europe.—M. Lisbonne, late Director of Construction in the French Navy, has collected statistics showing the number of torpedo-boats completed and under construction in the principal navies of Europe. He divides these vessels into four classes:

1. Sea-going torpedo-boats, from 130 ft. to 150 ft. in length, and from 70 to 160 tons displacement.
2. First-class torpedo-boats, from 108 ft. to 115 ft. in length, and from 45 to 60 tons displacement.
3. Second-class torpedo-boats, from 85 ft. to 95 ft. in length, and from 25 to 35 tons displacement.
4. Torpedo *vedettes*, or launches, from 50 ft. to 60 ft. in length, and from 10 to 13 tons displacement.

The sea-going boats may be again subdivided into those furnished only with the ordinary torpedo tubes or guns, and those provided with automobile torpedoes and apparatus for launching them.

The number of these boats for each of the navies of the leading powers is:

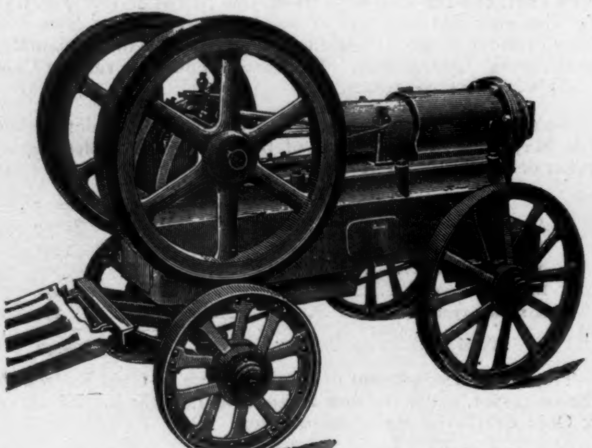
	1. Sea-going.	2. First-class.	3. Second-class.	4. Vedettes.	Total.
England........	74	6	19	37	136
France........	12	69	41	12	134
Italy........	57	9	29	22	117
Germany........	95	13	.	2	110
Austria........	23	26	8	..	57
Russia........	21	5	--	3	29

From this it will be seen that England and Germany have built chiefly the boats of the first and fourth classes, while Italy has also given most attention to the first class, although building also a number of the smaller ones. France, on the other hand, has built but few of those classes, having a large number of the second and third classes.

It may be noted that the torpedo-boat, built entirely for speed and loaded with all the machinery that can possibly be put on a vessel of the size, has proved, as might be expected, a very troublesome kind of ship to manage. They have yet to prove their usefulness in real warfare, but wherever they have been tried in conditions approaching those of actual service accidents and breakdowns have been numerous, and a practice cruise has generally ended in a large number of cases for the navy yards and repair shops.

Portable Petroleum Engine.—The accompanying illustration, from the London *Engineer*, shows a portable engine using petroleum, which is manufactured by Priestman Brothers, of Hull, England. The engine shown in the cut is of 6-H.P., and needs only the attachment of a horse to make it ready for transportation in any direction.

The engine itself consists of the cylinder, piston, rod, crank-shaft, etc., all fitted upon a massive cast-iron bed-plate of box



form, which has fitted also inside the oil tank, vaporizer, all pipes and connections, hand pump, and heating lamp for starting, etc.; this is all secured to a wrought-iron framing, which in its turn is mounted upon substantial carriages, axles, and wheels. The water for cooling the cylinder is taken from a tub placed upon the ground, and is circulated by means of a small water pump fitted inside the bed-plate. The battery, etc., for giving the electric spark for firing the charge in the cylinder, is carried at the end of the engine in a strong wooden box secured to the bed-plate. The engine is fitted with two fly-wheels, and the fore-carriage is arranged in the usual way, with shafts for a horse. The whole machine is compact, and the total weight is much less than an ordinary portable steam-engine of equal power.

The engine is on the same principle as the Priestman stationary engine, which was described in the JOURNAL for June, 1888, page 288. It is a gas engine, the gas being produced directly by vaporizing petroleum.